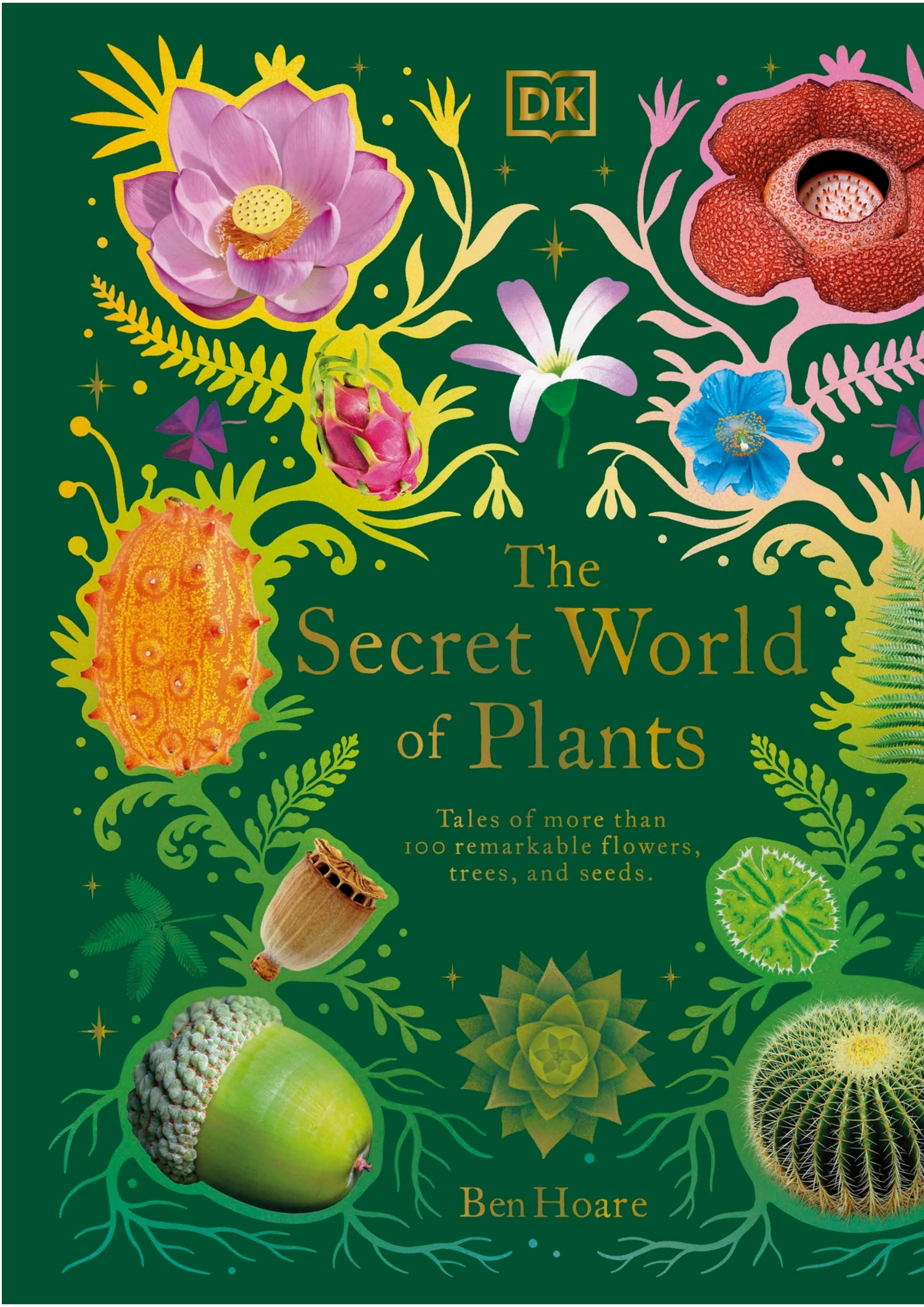
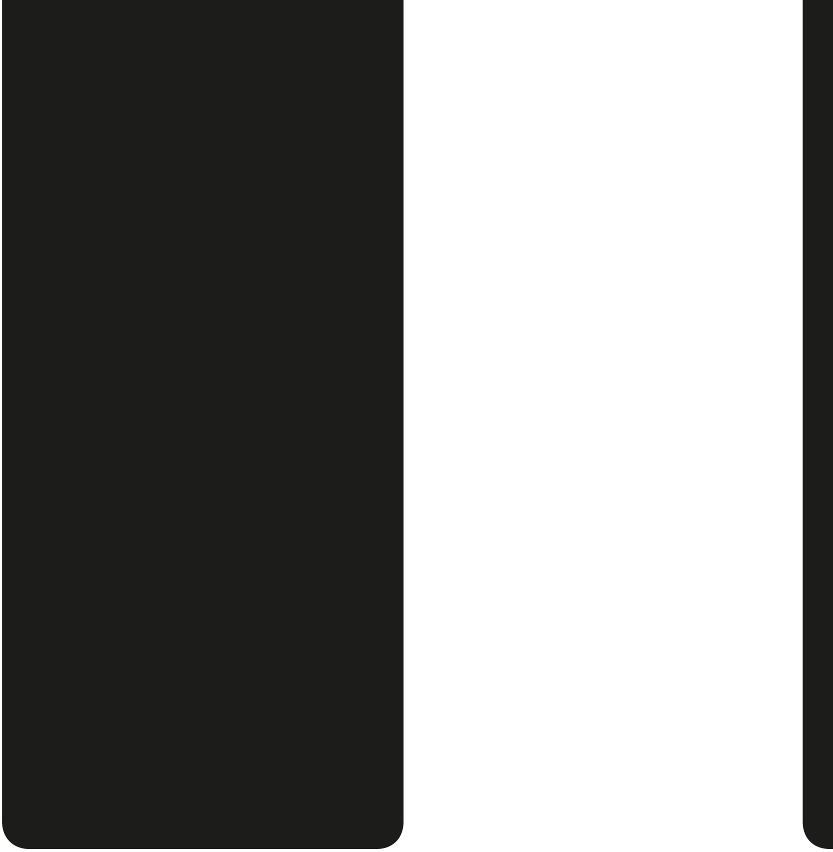


DK

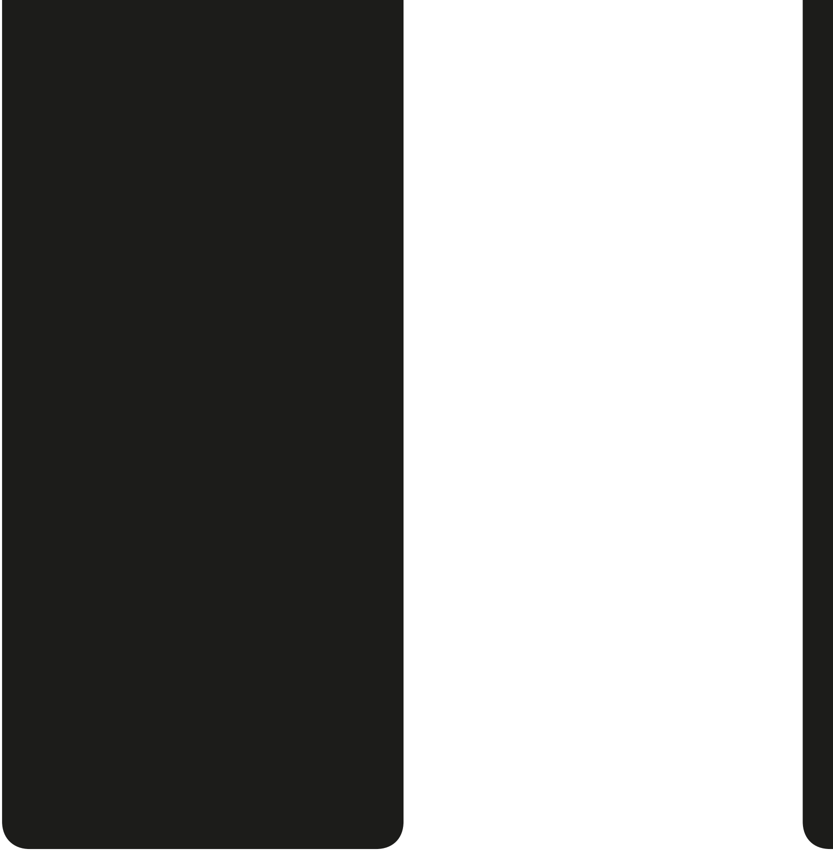
The Secret World of Plants

Tales of more than
100 remarkable flowers,
trees, and seeds.

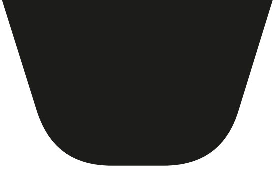
Ben Hoare

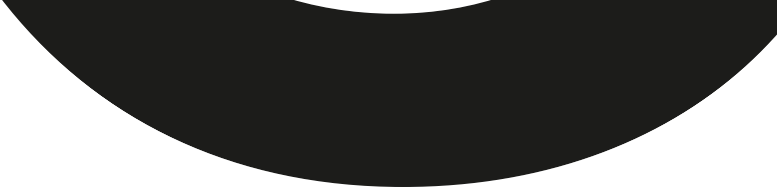


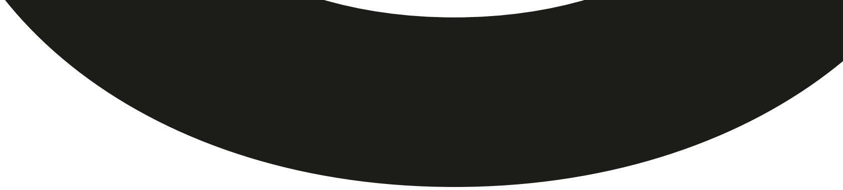
p

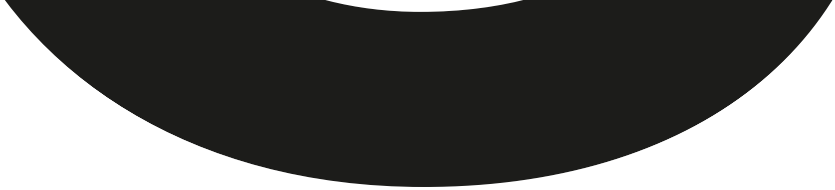


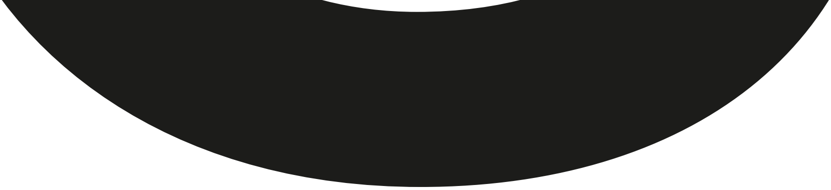
Contents

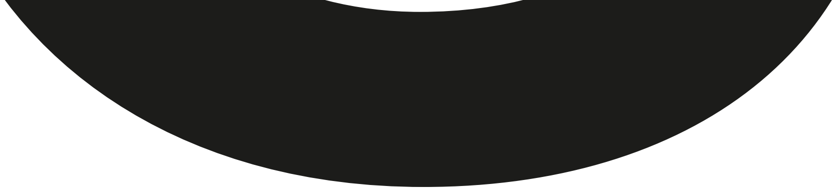


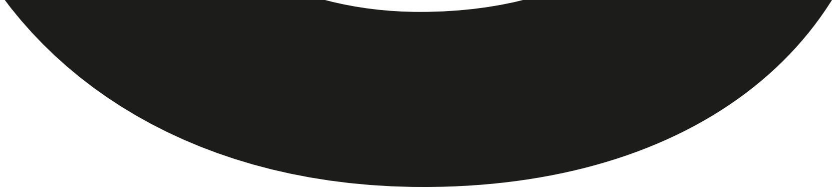


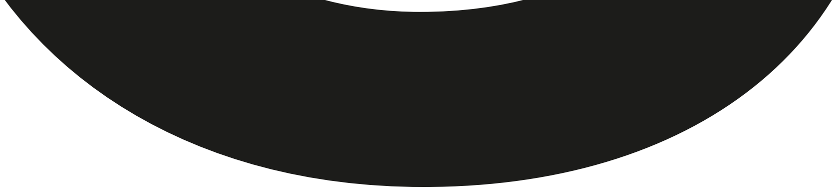


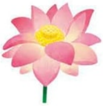


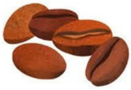


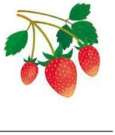


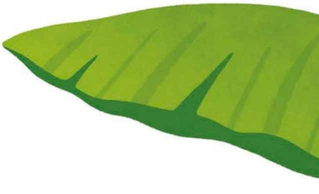


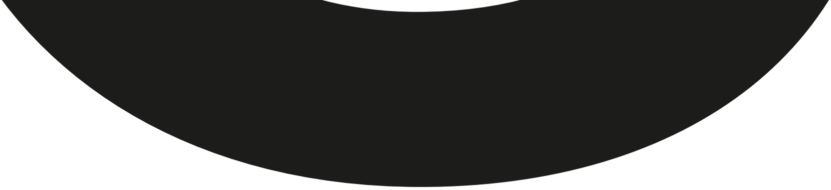


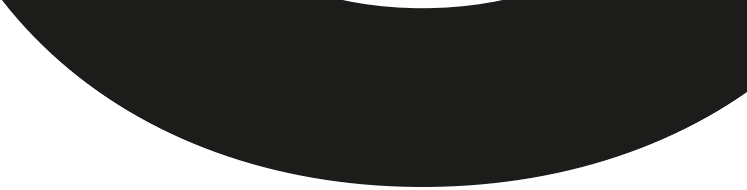


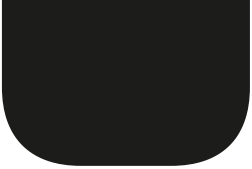


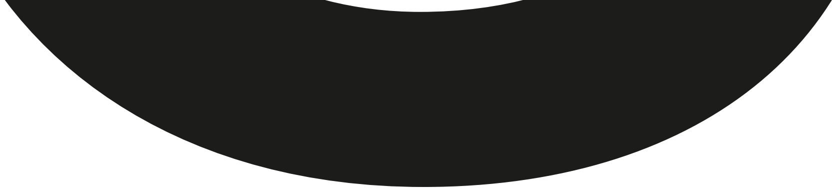


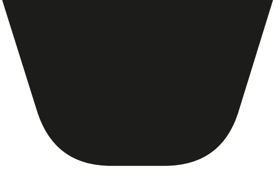


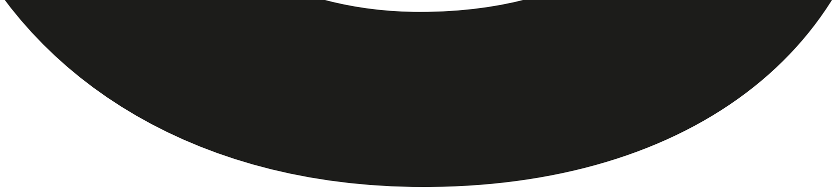


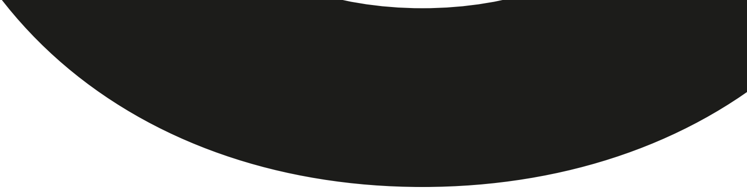


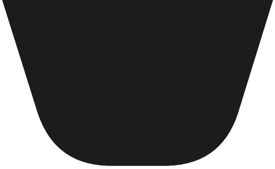


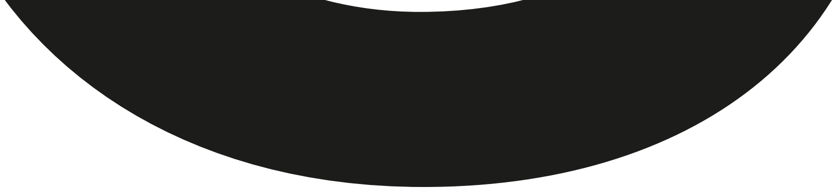


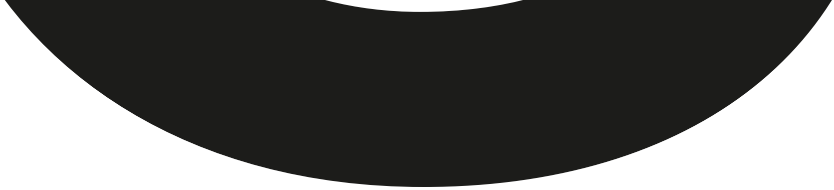












Safety warning

Plants can be interesting to examine and are sometimes very tasty, but be careful—they can also be poisonous to touch or eat. Some people are also allergic to certain plants. If you're not sure what kind of plant you are looking at or if it is safe to handle or eat, always ask an adult for advice. In any case, it's usually a good idea to leave plants alone, to help them thrive, and to allow other people to enjoy the beauty of nature, too.

P

S

a

a

SU

is

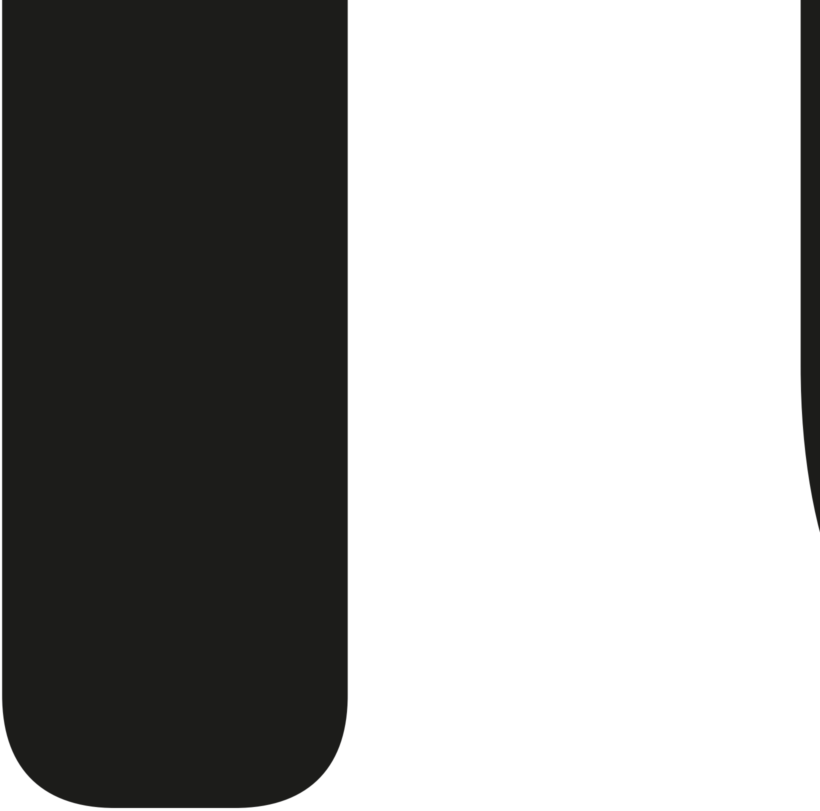
a

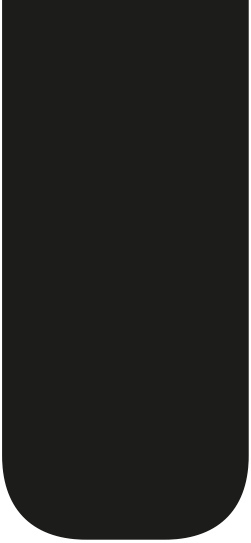
le

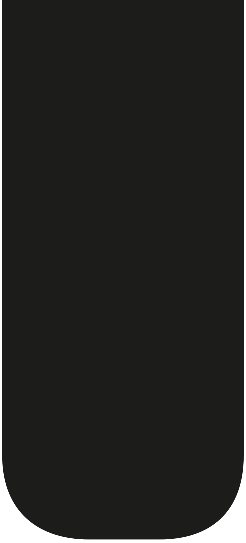
a

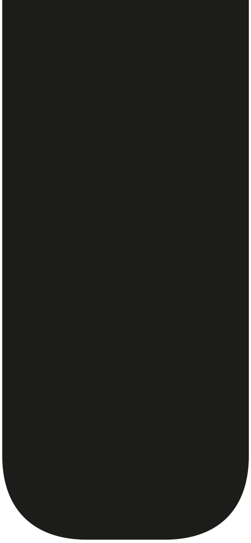
n

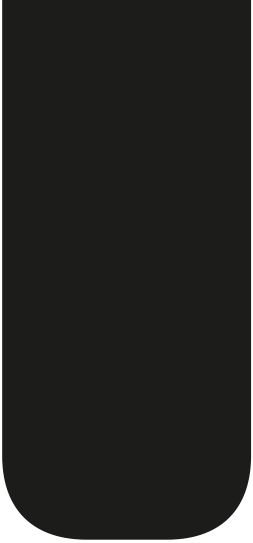
Introduction

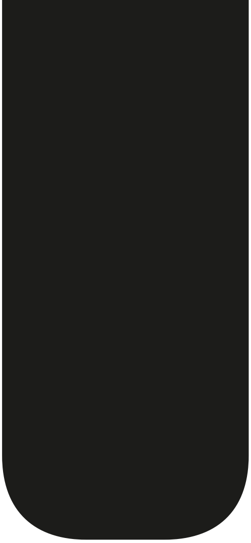




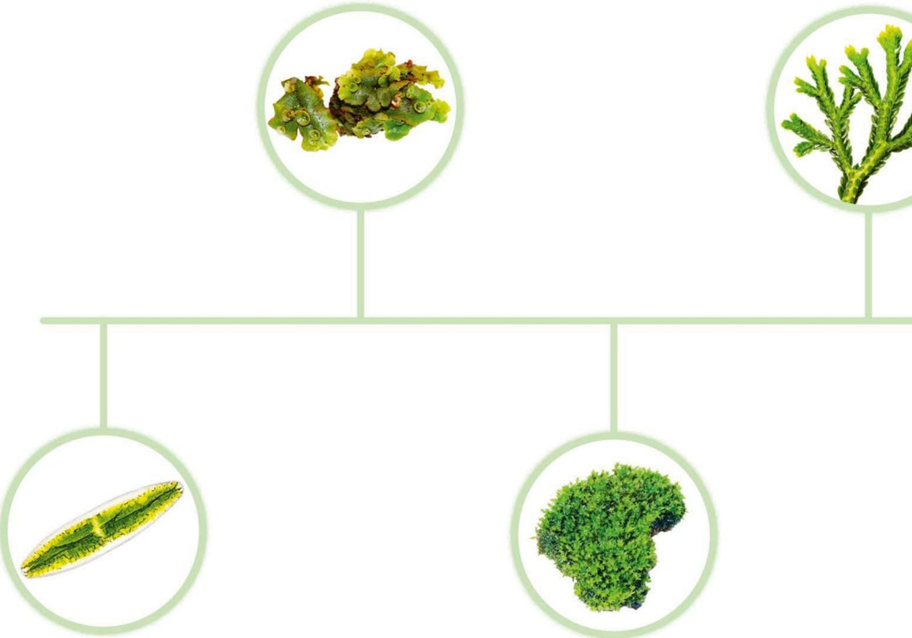






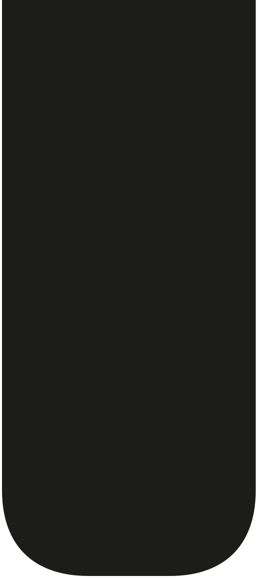


World of plants



Tree of life

We can use a diagram called a tree of life to show how different plants are related. The first plants to appear on Earth are on branches on the left. Plants that developed more recently are on the right.



W

sh

p

th

a

C

T

th

Ve

m

4

Li

Li

th

a

ye

le

M

A

o

sh

le

in

G

Th

in

a

p

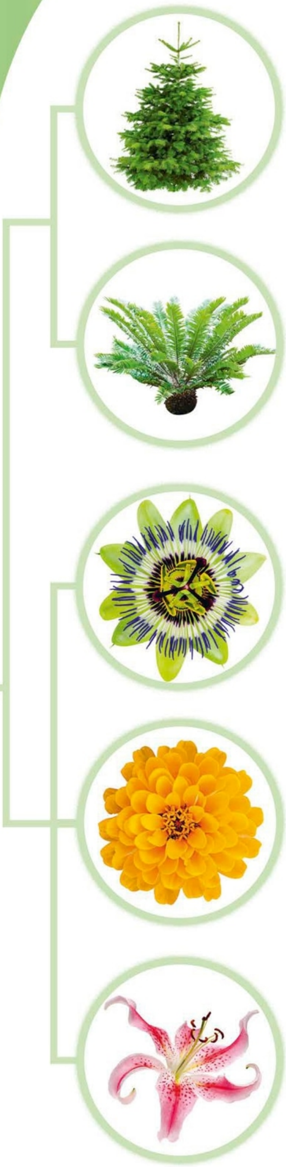
ju

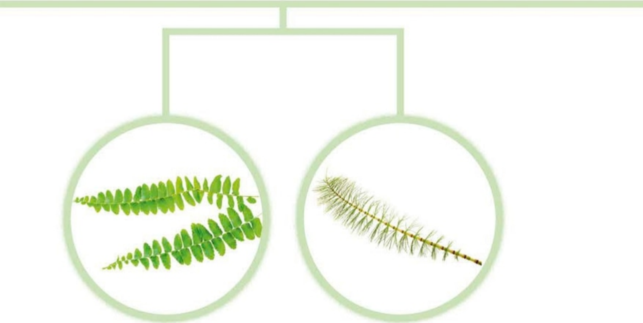
Fungi

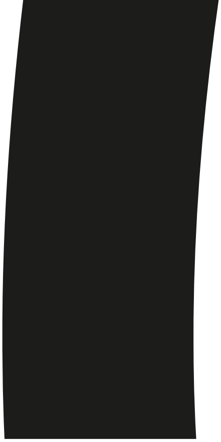
Fungi may look similar to plants but are a different type of organism. They live in soil and wood or on animals and plants. Most of a fungus is hidden—the part we see, such as a mushroom, is the structure that makes seedlike spores to reproduce.

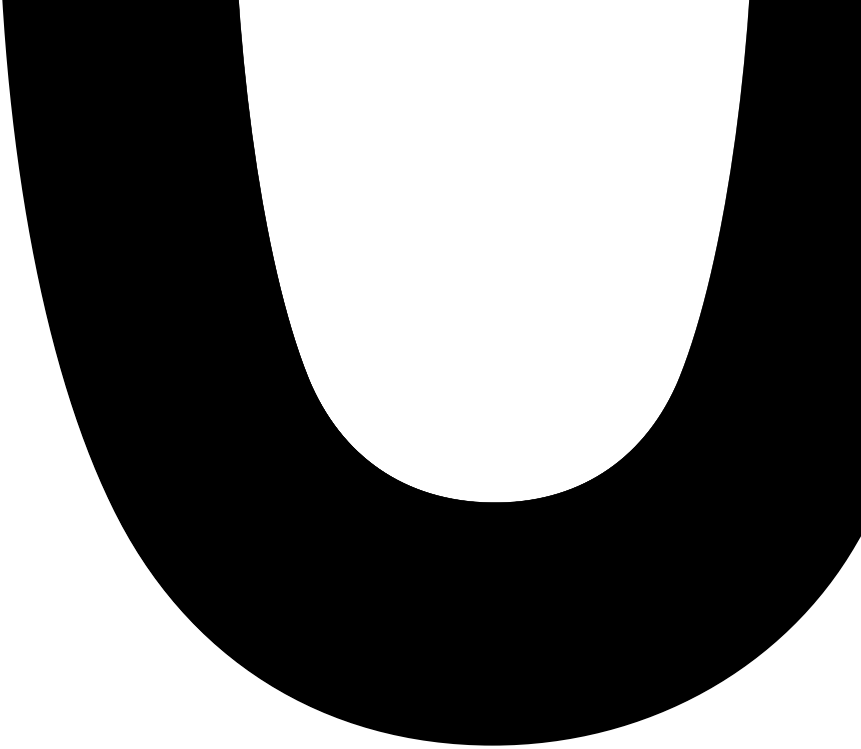
Lichen

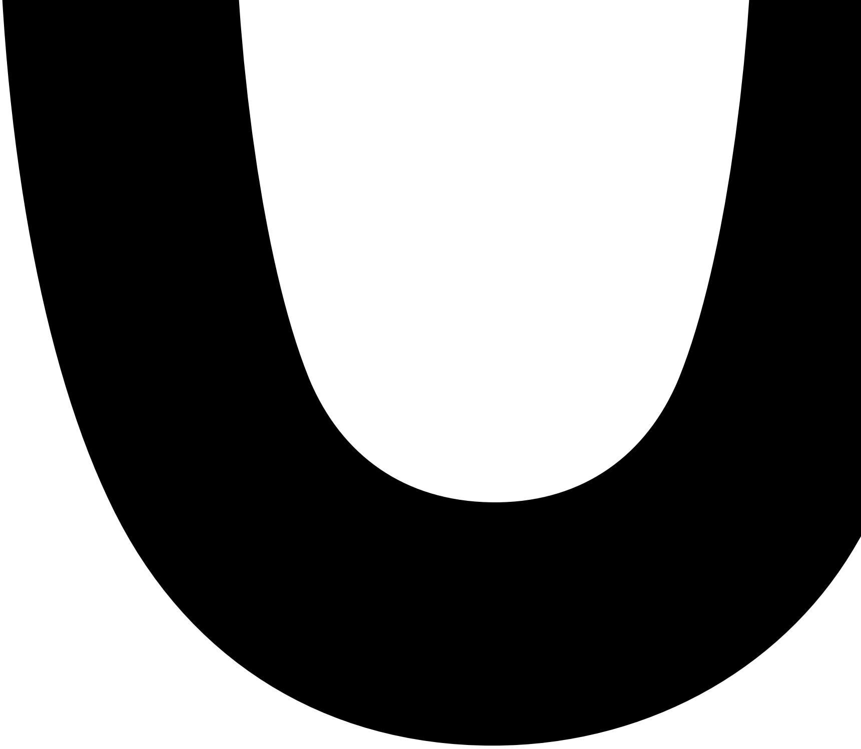
Like fungi, lichens are not plants. Each lichen is a partnership between an alga and a fungus. The alga makes food from sunlight, and the fungus provides water and a body for the partners to share. Lichens are often seen growing on rocks and trees.







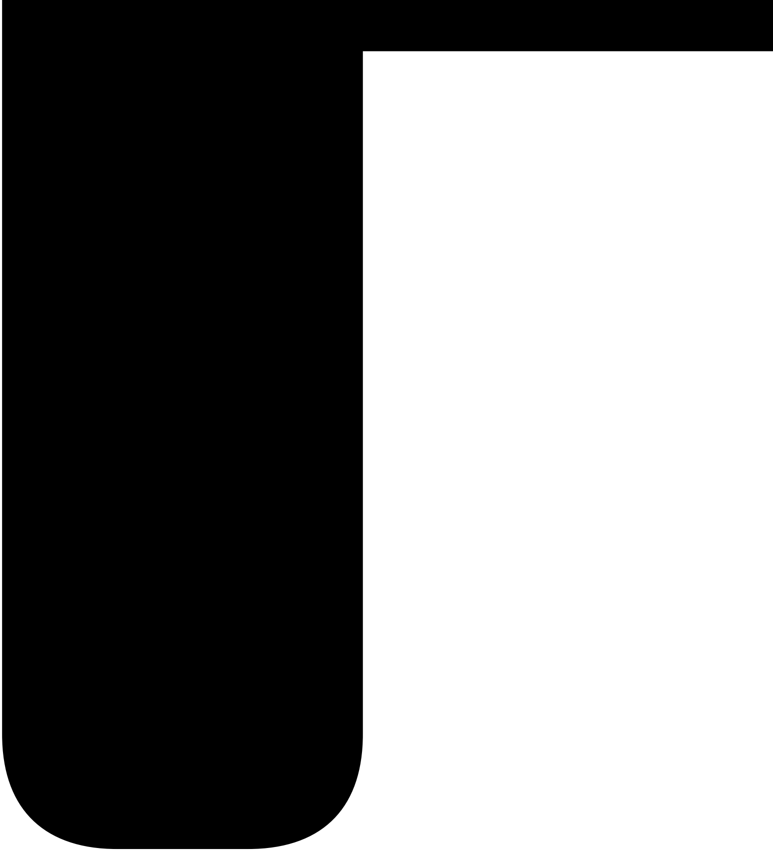




[redacted]

[redacted]

[redacted]



F

p

ty

S

a

is

SU

th

Se

Li

E

b

T

SU

w

t

g

F

N

w

fl

fe

m

a

fr

m

ye

F

F

th

fi

36

sp

sp

C

C

a

fe

C

S

m

a

32

H

H

le

th

h

re

3

C

Li

h

T

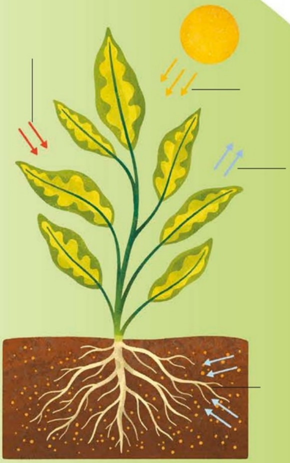
p

Si

T

30

Leaves

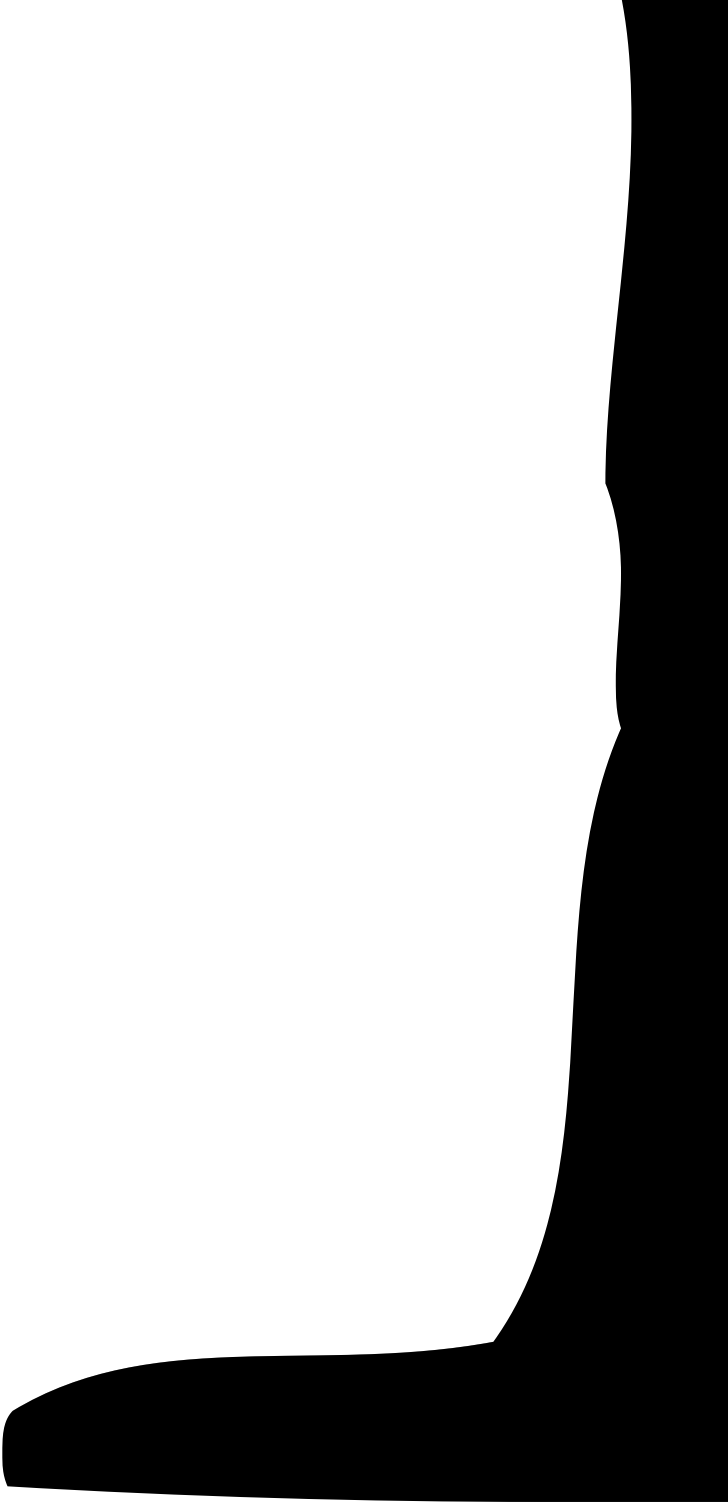


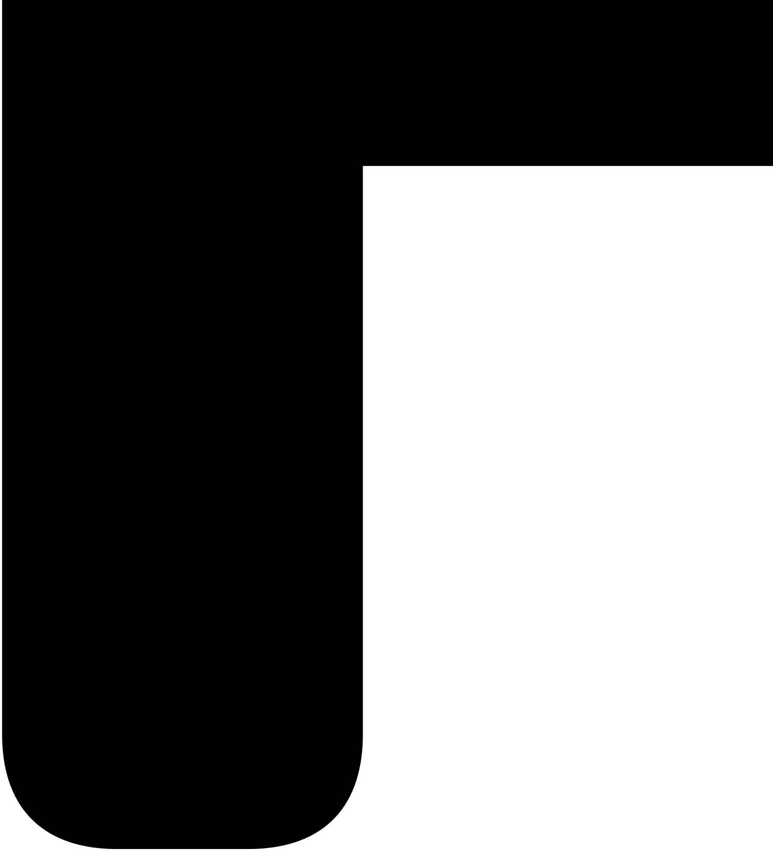
Photosynthesis

Leaves use sunlight to combine carbon dioxide from the air and water from the soil. This chemical reaction produces sugars, which allow the plant to grow. Oxygen is also produced, most of which is released by the leaves.

Deciduous or evergreen?

Deciduous trees drop all their leaves in the fall or the dry season, and replace them in spring or in the rainy season Their leaves change color before they fall as their chlorophyll breaks down, which reveals other colorful pigments. Evergreen trees have green leaves all year long





Le

C

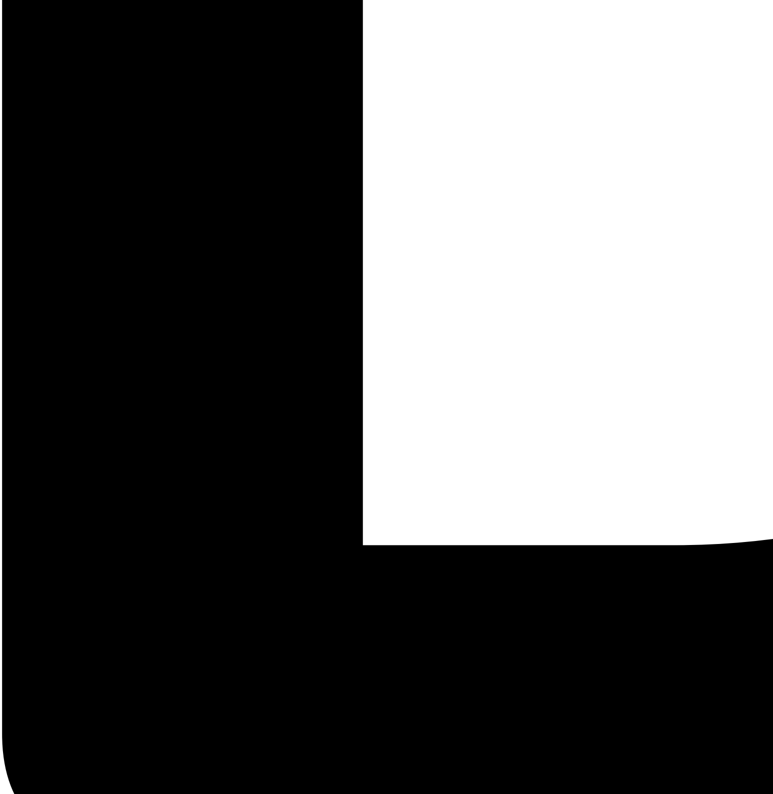
w

re

a

a

re



D

Se

T

C

p

D

le

S

ri

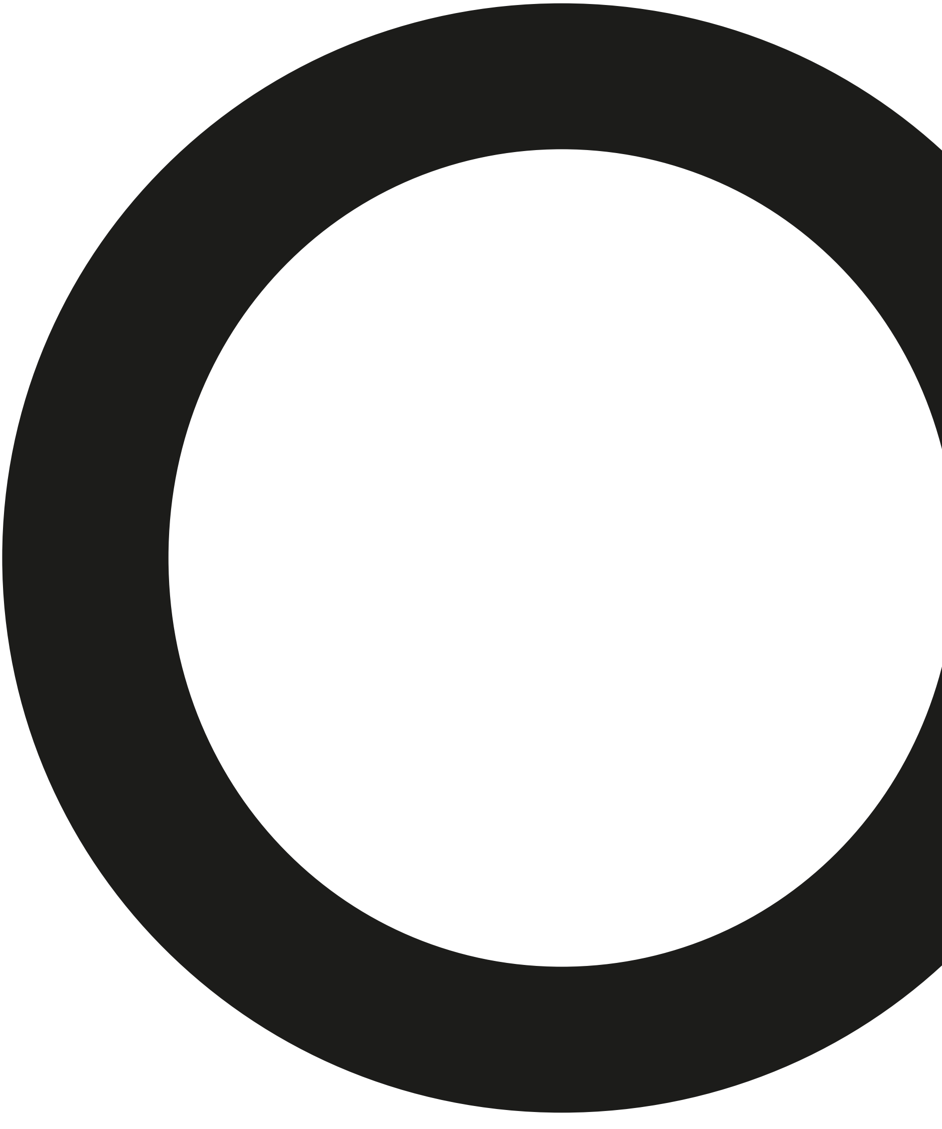
th

th

S

C

d



T

tr

th

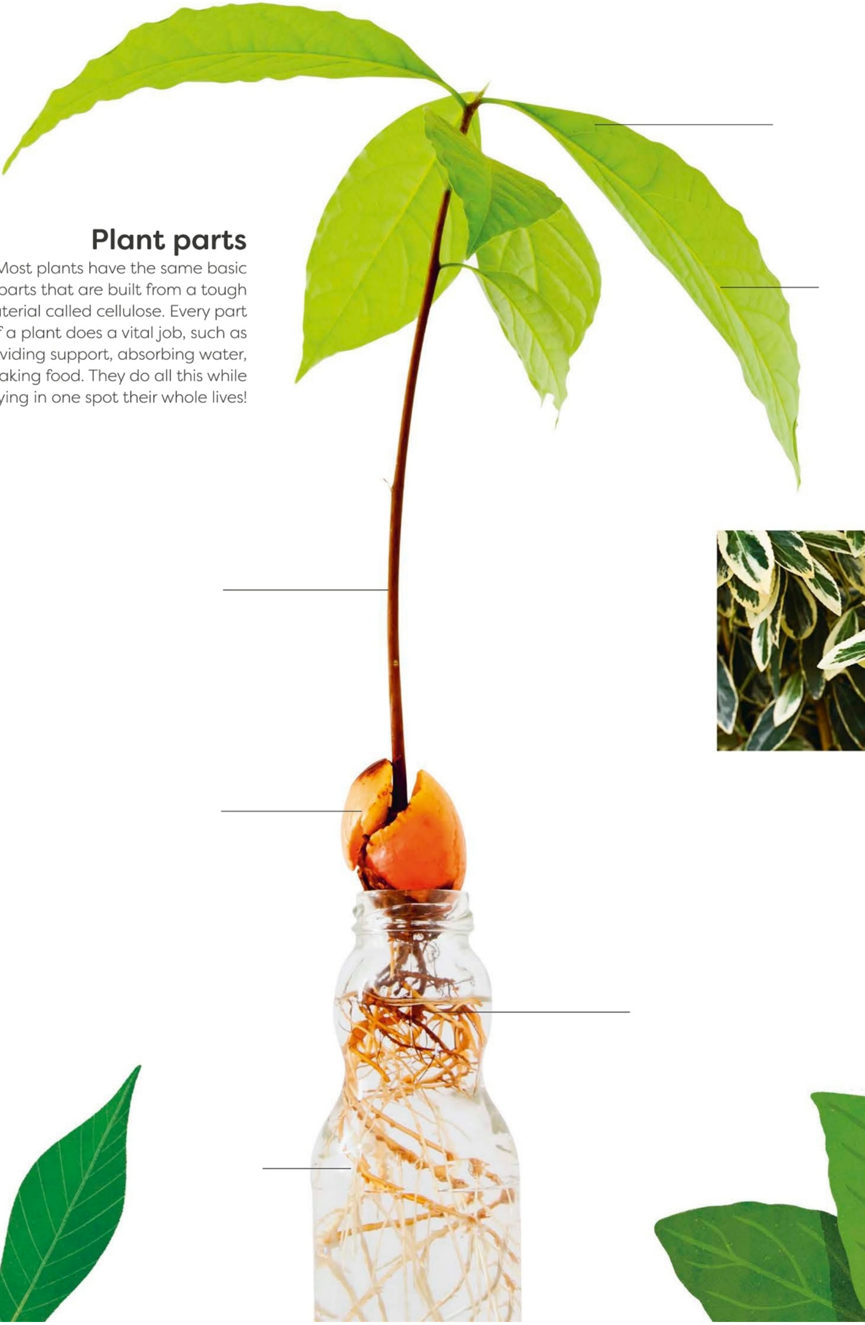
p

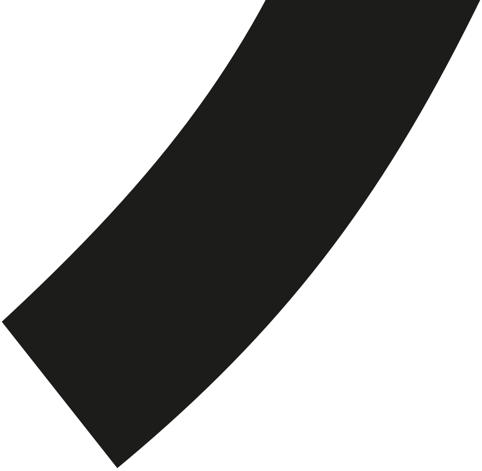
a

p

Plant parts

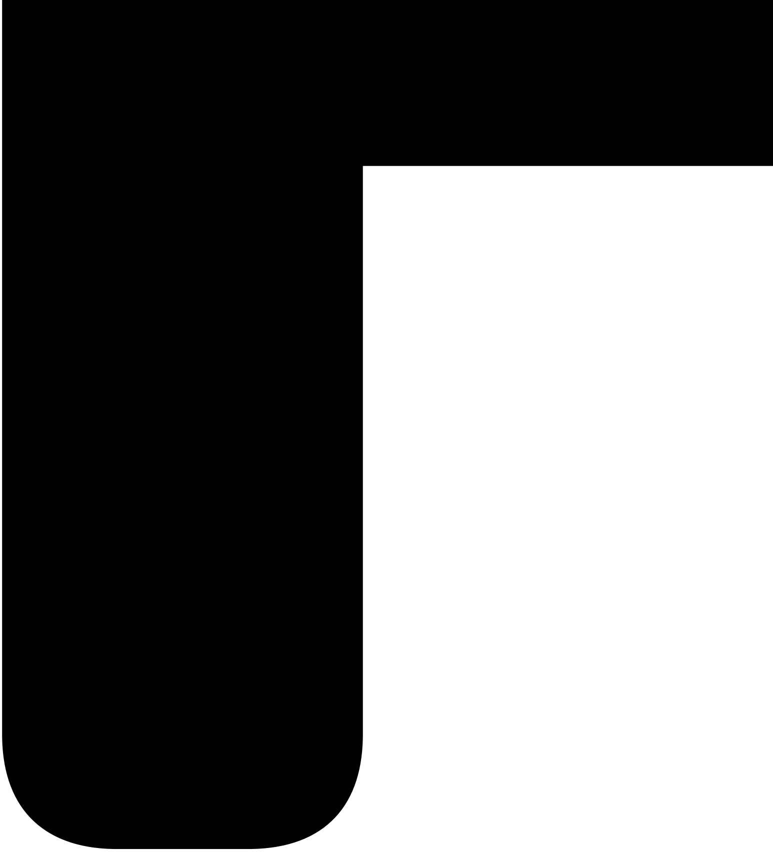
Most plants have the same basic parts that are built from a tough material called cellulose. Every part of a plant does a vital job, such as providing support, absorbing water, or making food. They do all this while staying in one spot their whole lives!





L

V



M

p

m

O

p

o

st

L

M

t

SU

T

le

b

S

A

p

g

m

R

R

st

h

a

S

Fl

a

se

SU

g

L

A

ve

le

nu

w

R

M

f

V

a

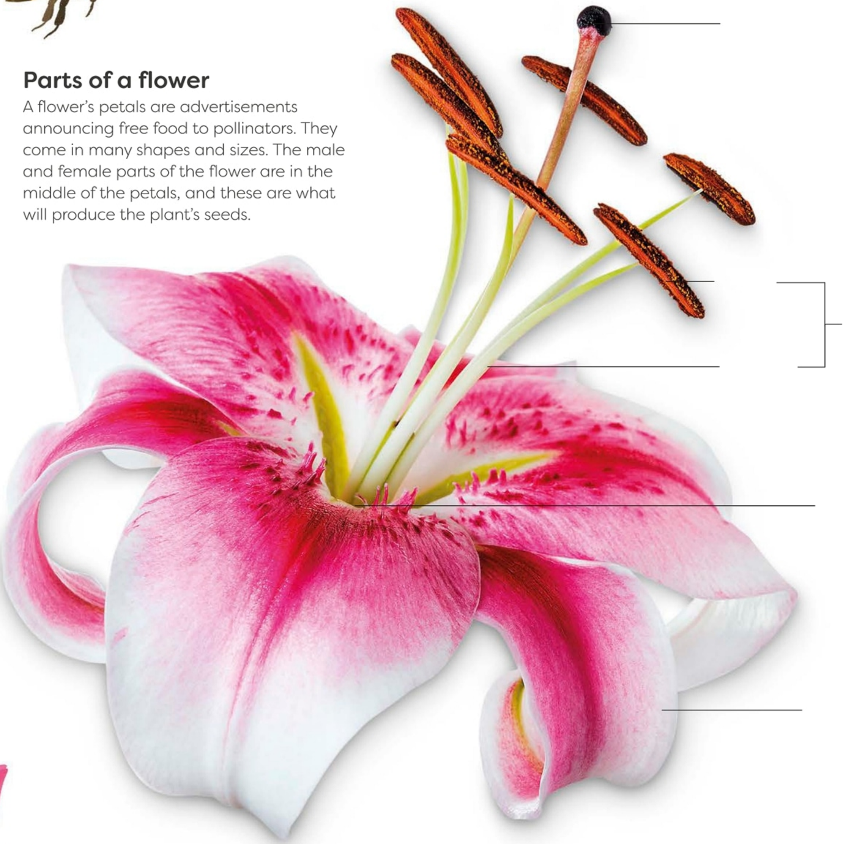
T

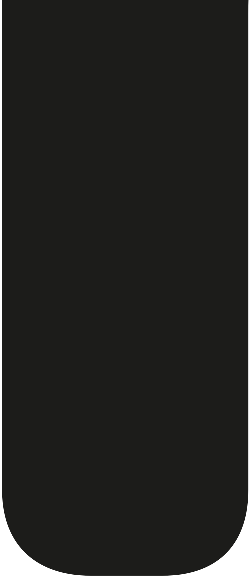
k

Flowers

Parts of a flower

A flower's petals are advertisements announcing free food to pollinators. They come in many shapes and sizes. The male and female parts of the flower are in the middle of the petals, and these are what will produce the plant's seeds.





F

A

S

M

h

fil

e

w

p

P

Pe

S

p

W

S

T

fe

fl

h

A

a

C

a

m

W

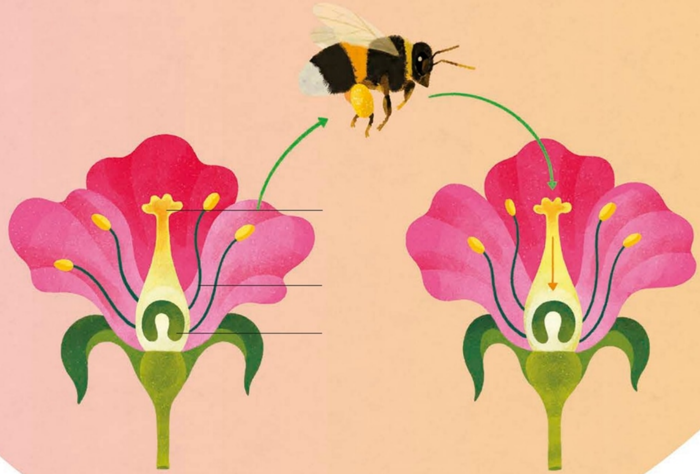
N

N

th

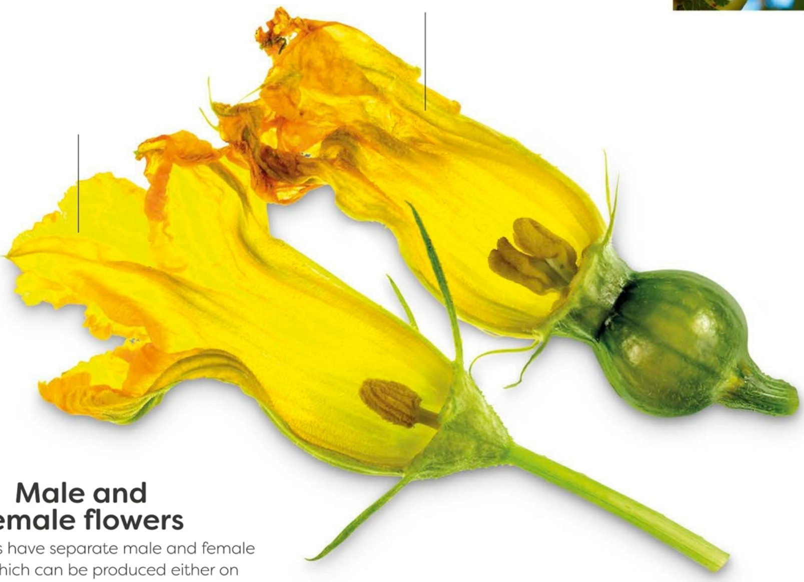
in

F



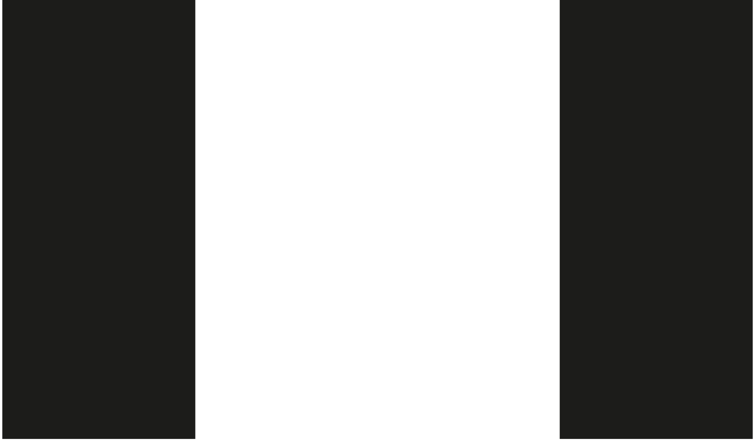
Pollination

Pollination occurs when po
moved from the stamen of
to the stigma of another flo
same type, usually by a pol
the wind. The pollen then g
that takes the male pollen
ovary. There, they join with
in a process called fertilizat
fertilized ovary makes seed

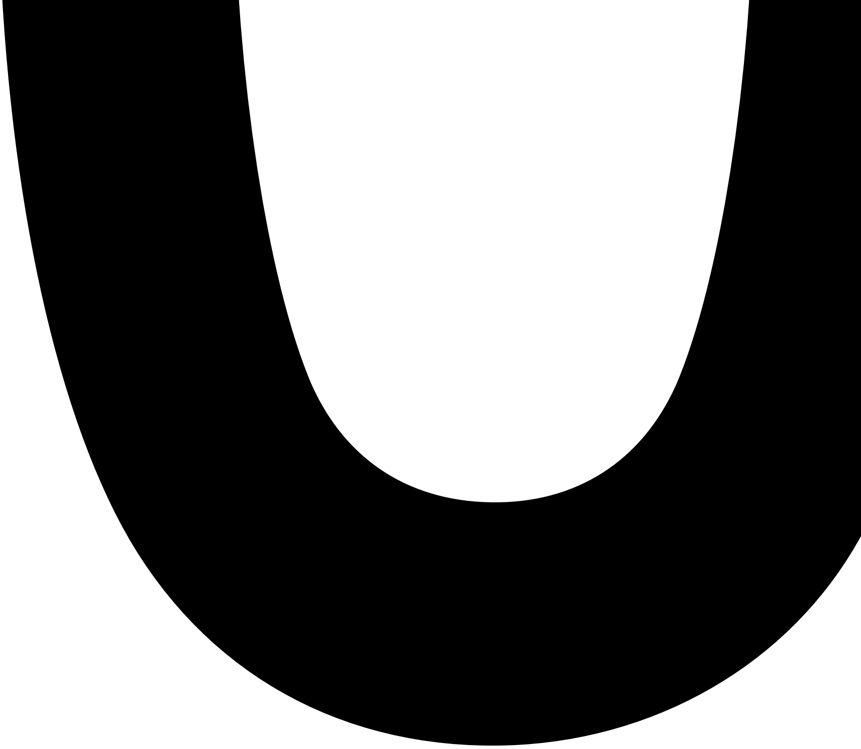


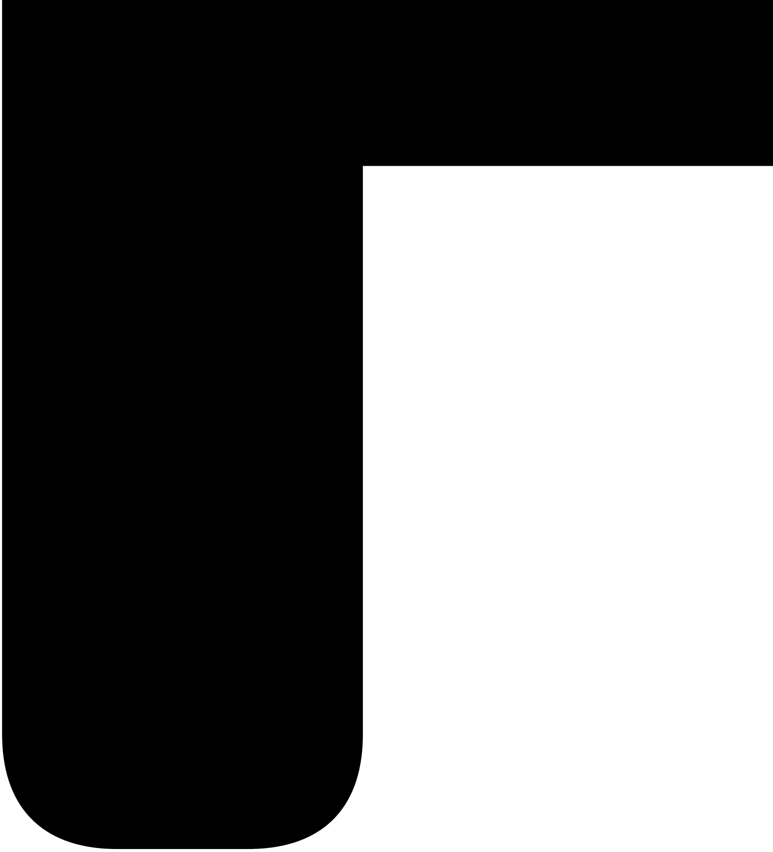
Male and female flowers

Some plants have separate male and female flowers, which can be produced either on separate plants or different parts of the same plant. The male flowers have only stamens, while the female flowers have stigmas.



[redacted]





P

m

t

S

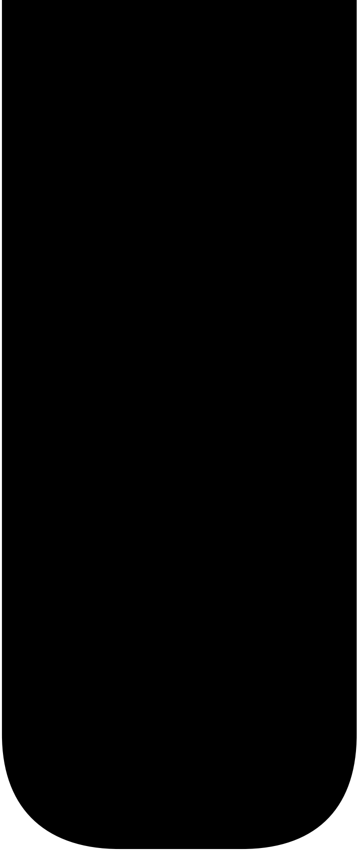
th

th

O

in

fe



S

fl

Se

p

W

M

S

F

S

W

fe

a

C

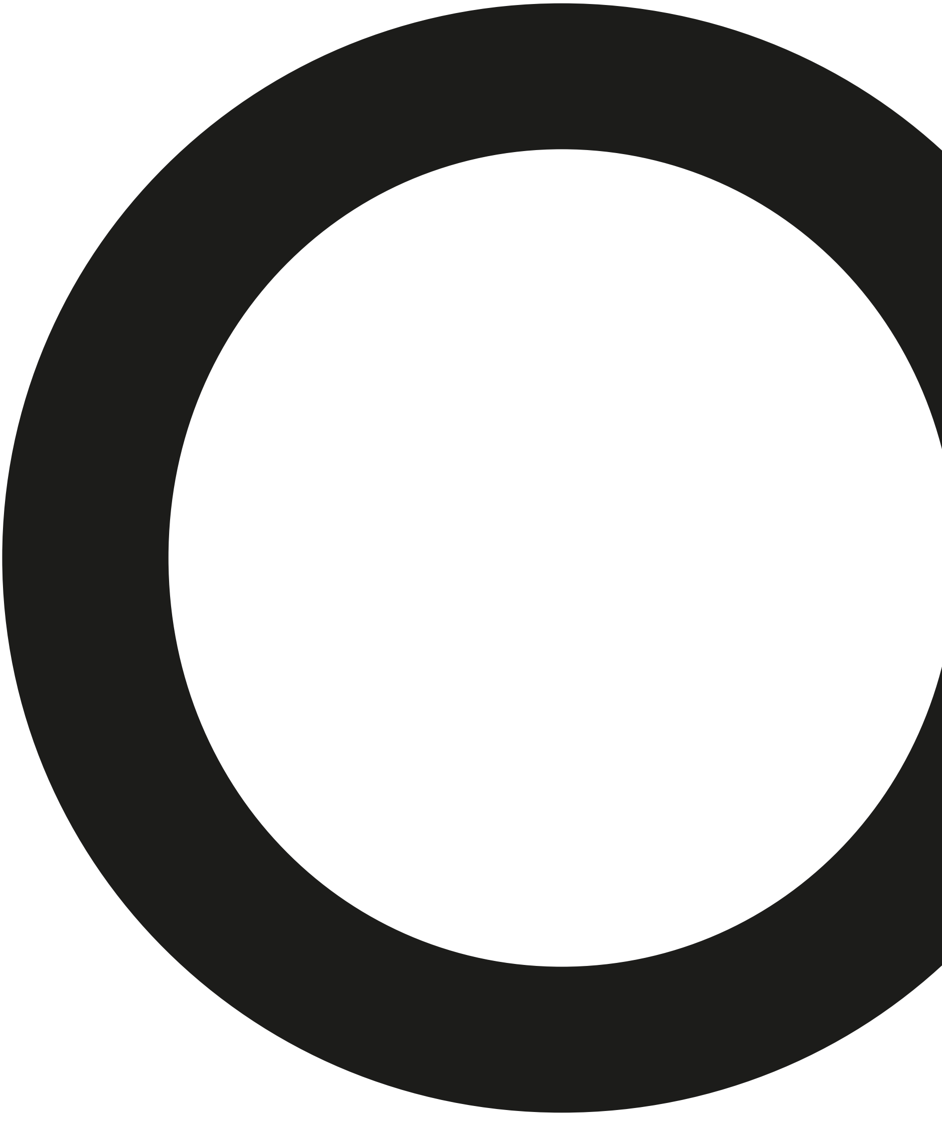
F

sr

Se

S

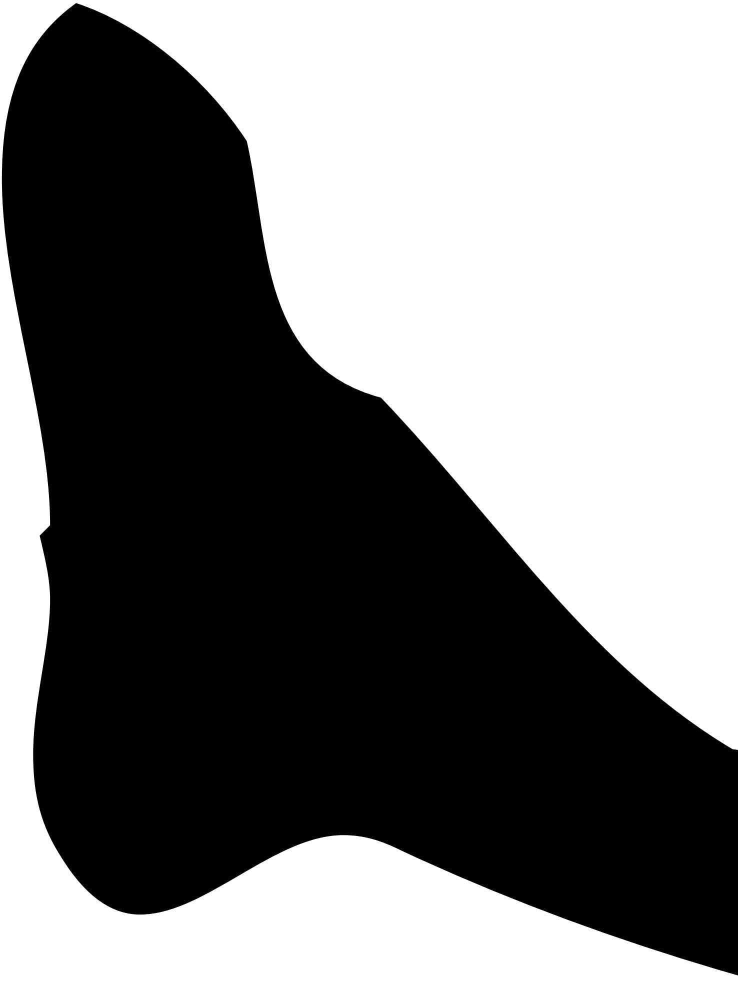
S

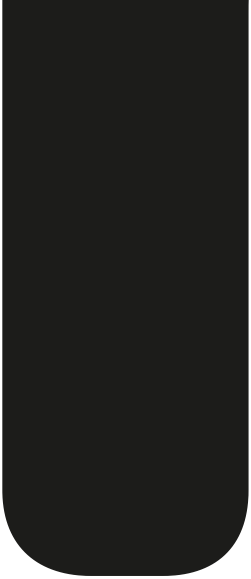


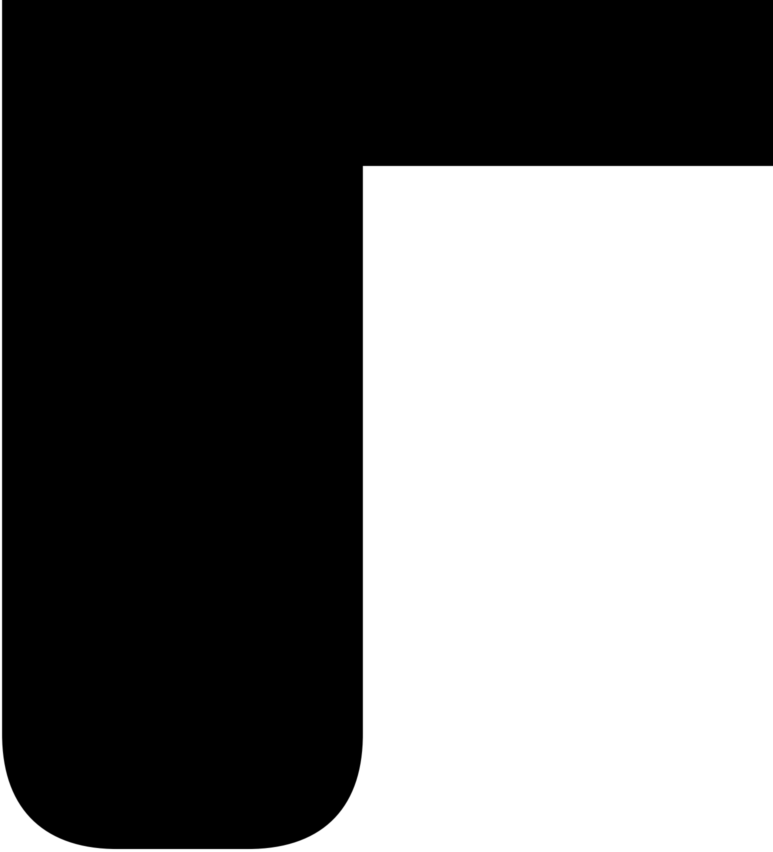
Seeds

Packaging seeds

Plants look after their seeds as carefully as they can. They package them in many ways, including in papery seedheads, hard nuts, woody cones, pulpy fruits, and fleshy pods, both to protect them and to help them spread.







P

C

th

p

C

b

th

S

Fl

th

th

R

P

th

a

W

p

S

E

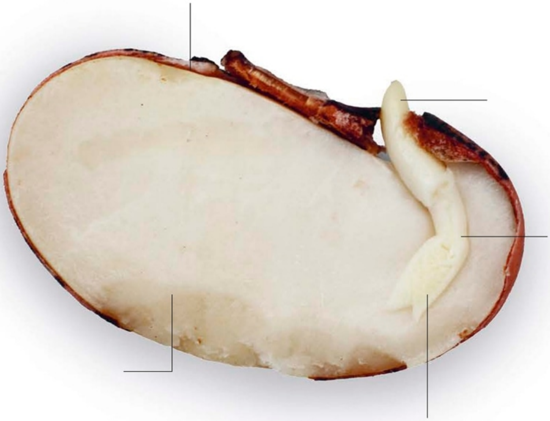
p

in

C

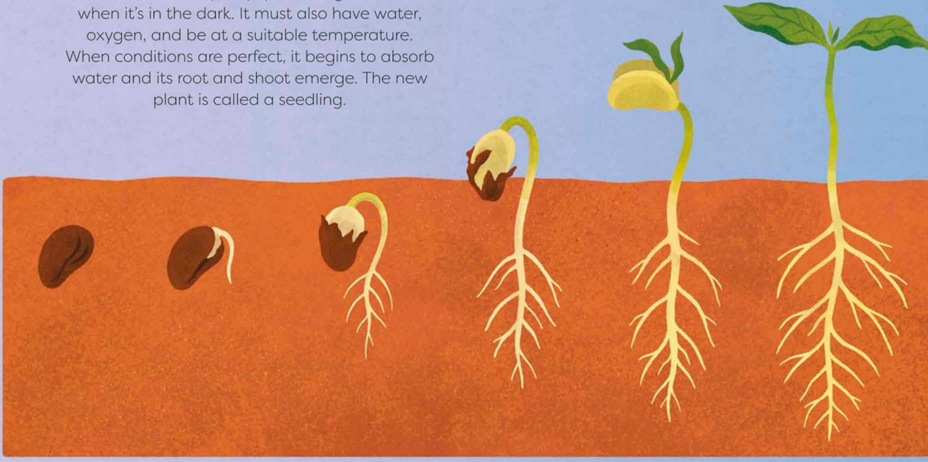
Inside a seed

Most seeds have a tough coat. This protects the embryo and its waiting root and shoot. There is also a food supply, which is in a pair of seed leaves or stored separately.



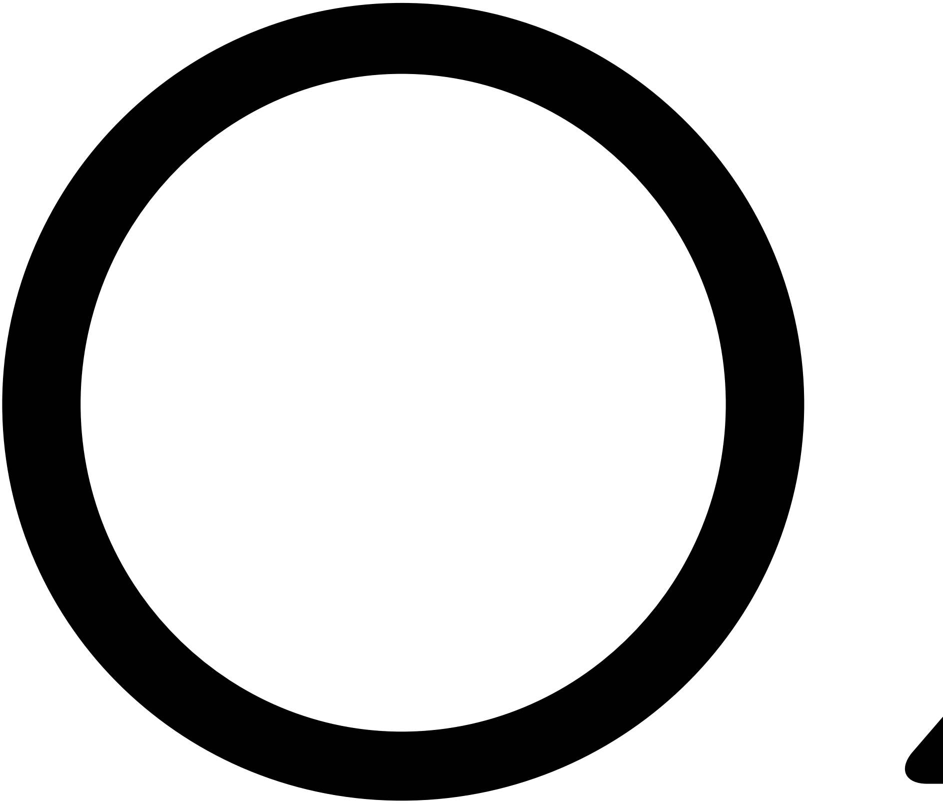
Germination

A seed will usually only sprout, or germinate, when it's in the dark. It must also have water, oxygen, and be at a suitable temperature. When conditions are perfect, it begins to absorb water and its root and shoot emerge. The new plant is called a seedling.



A

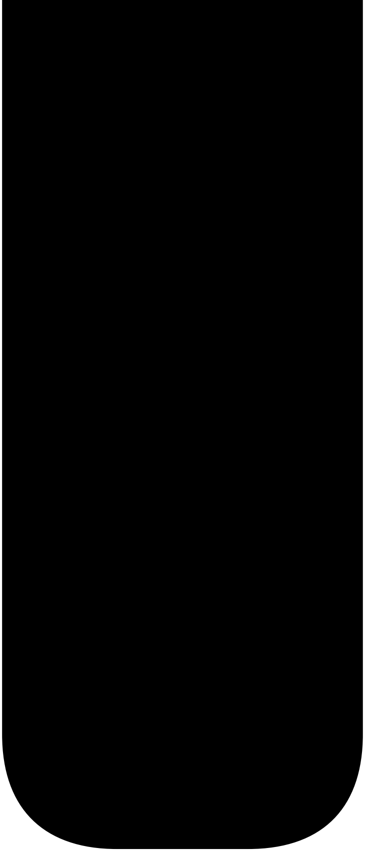
w



W

W

p



M

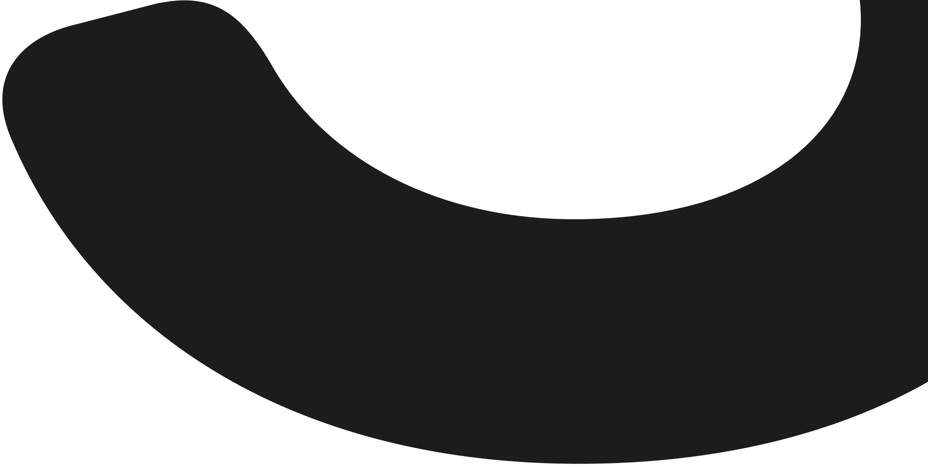
p

r

SU

le

S



P

Se

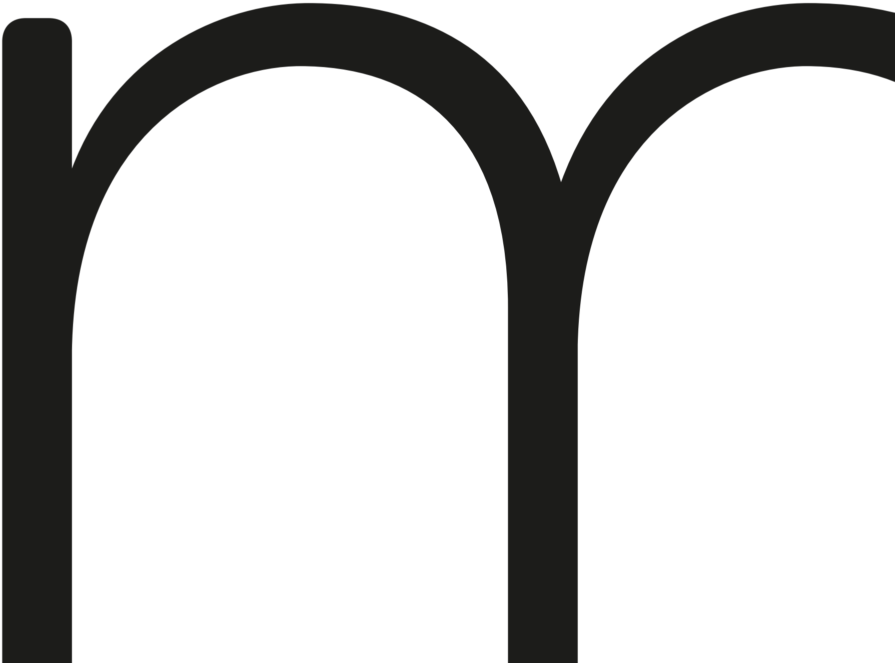
u

th

sp

S

T



se

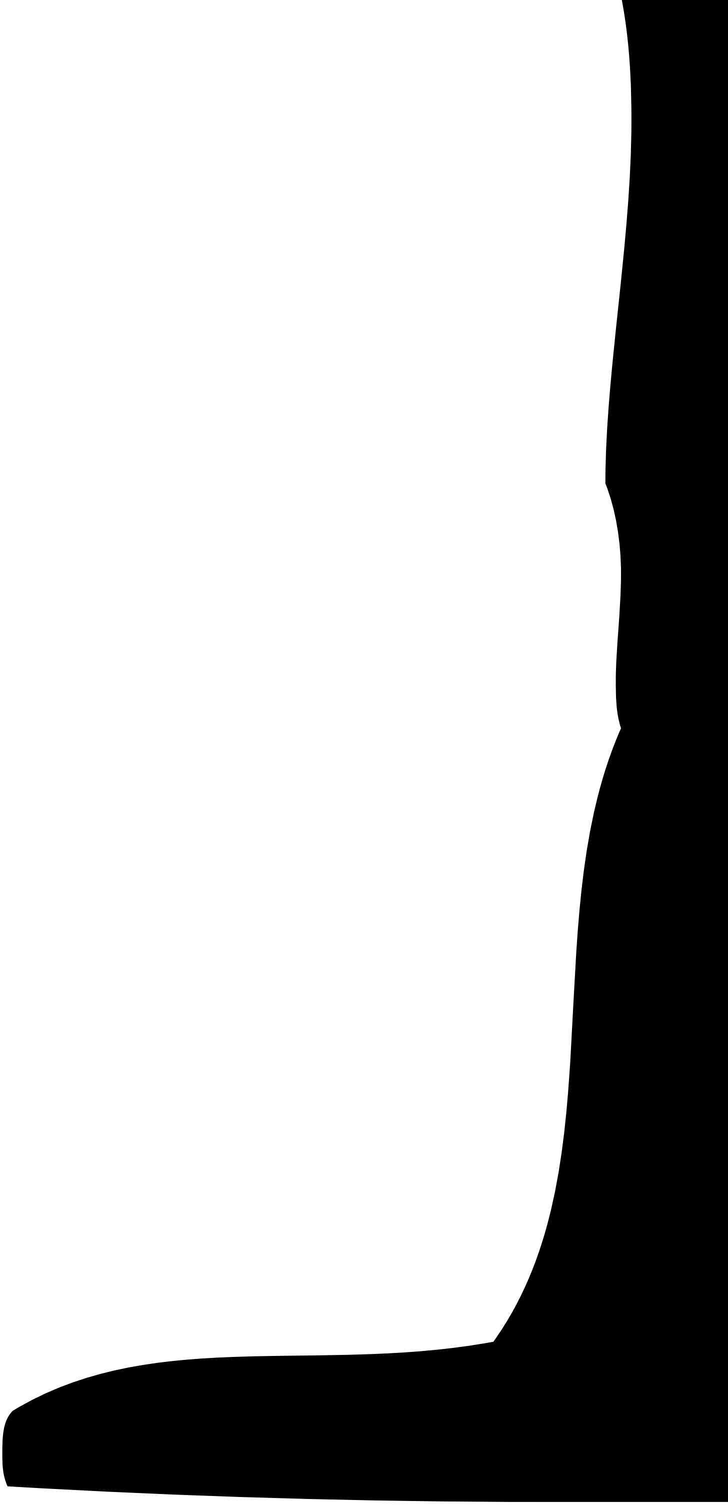
lik

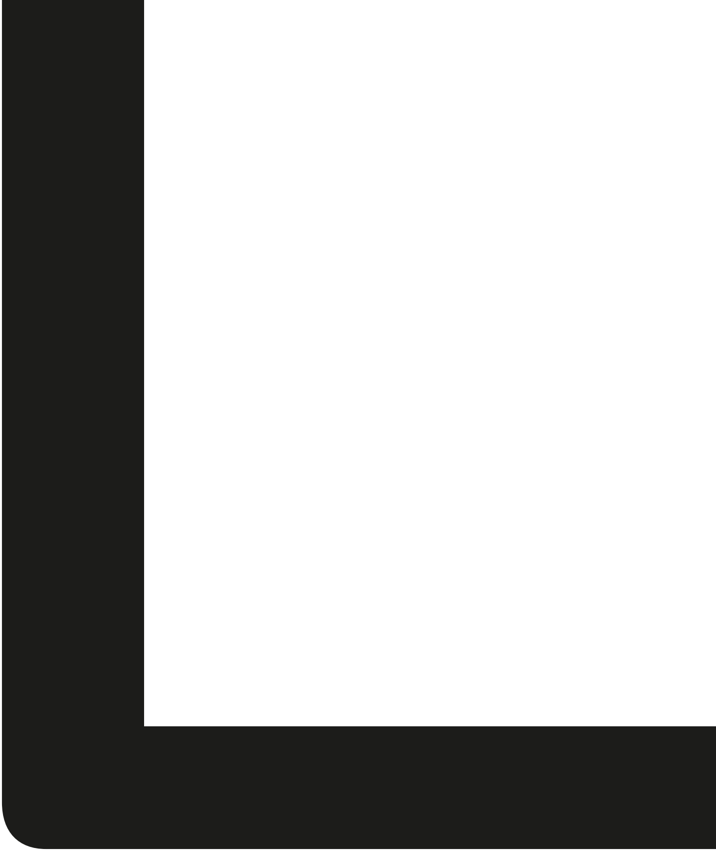
R

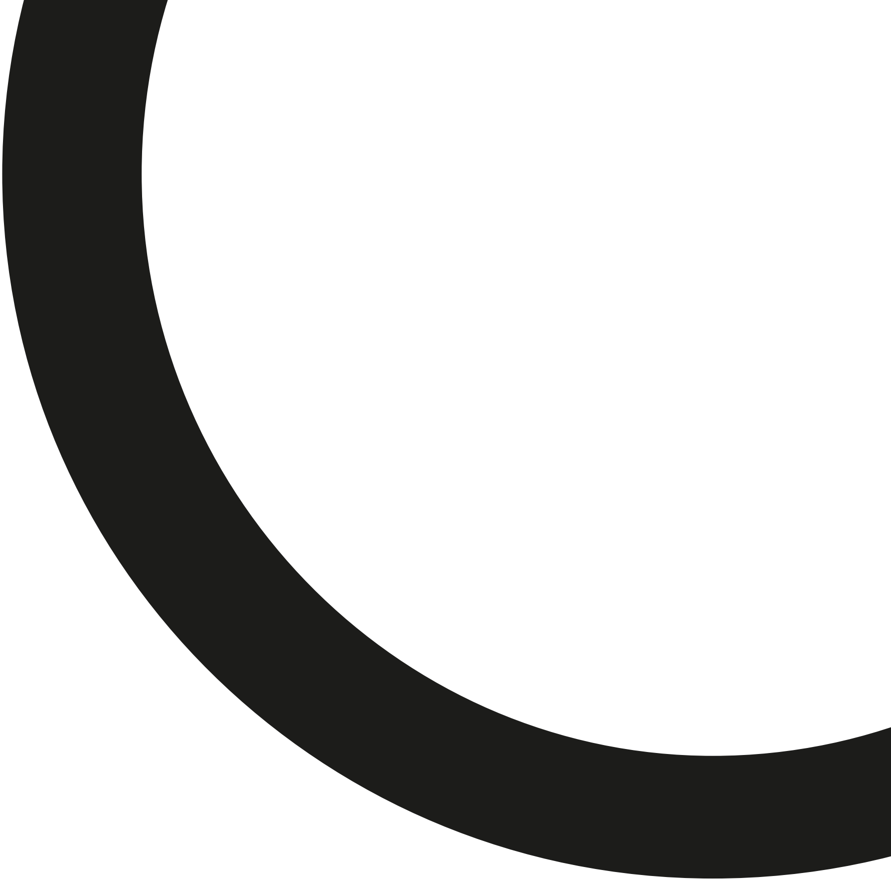
E

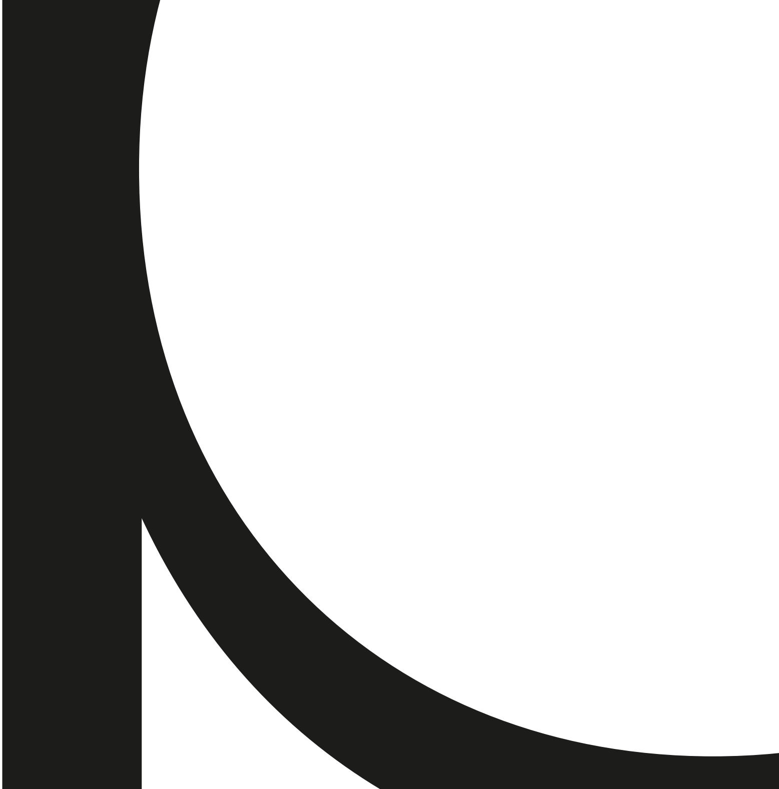
S

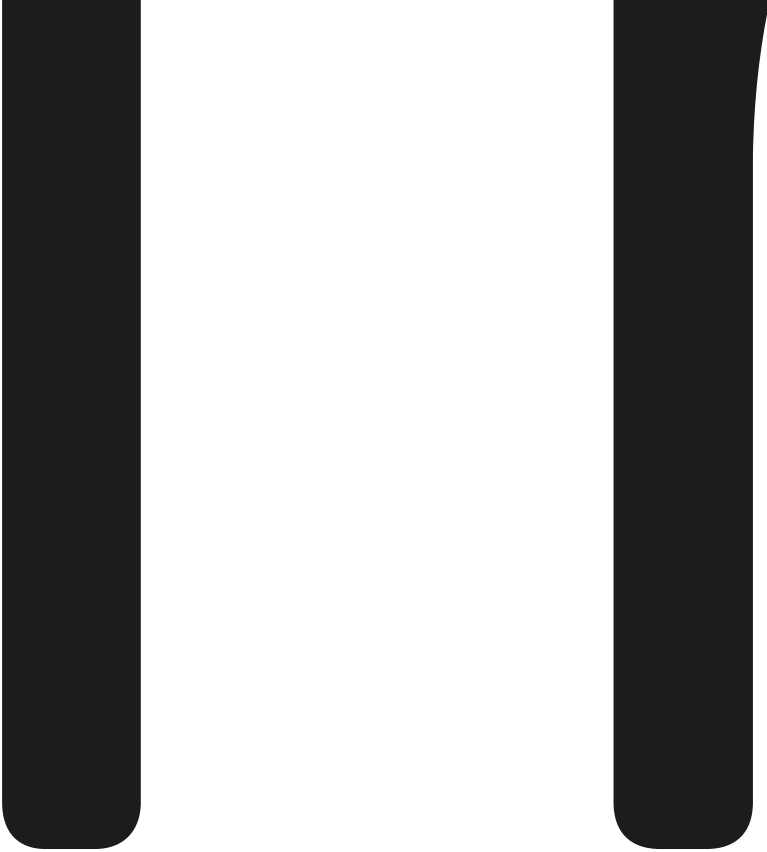
Leaves

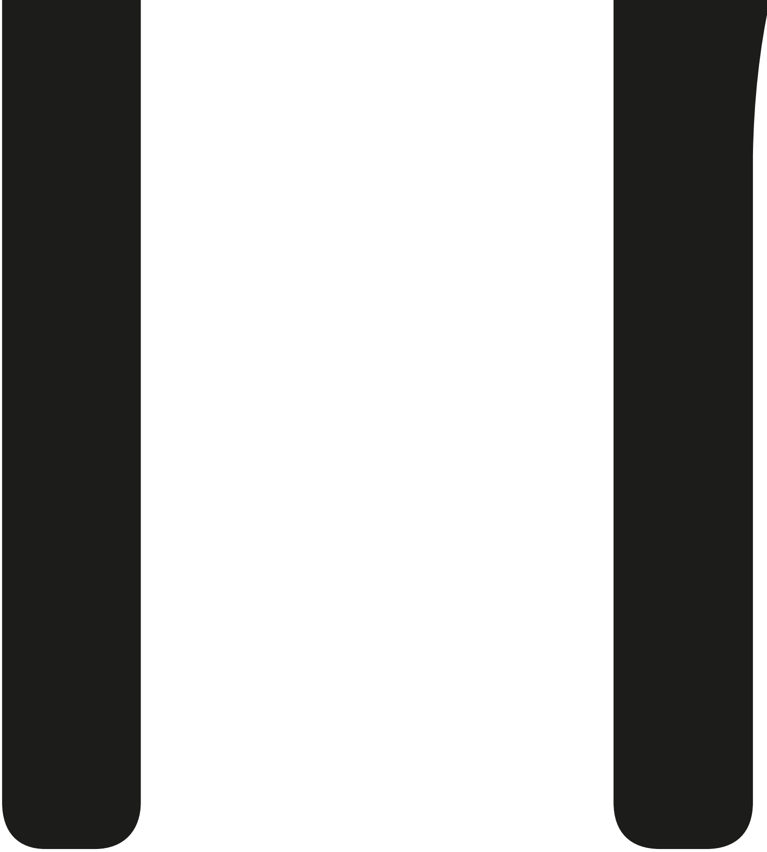


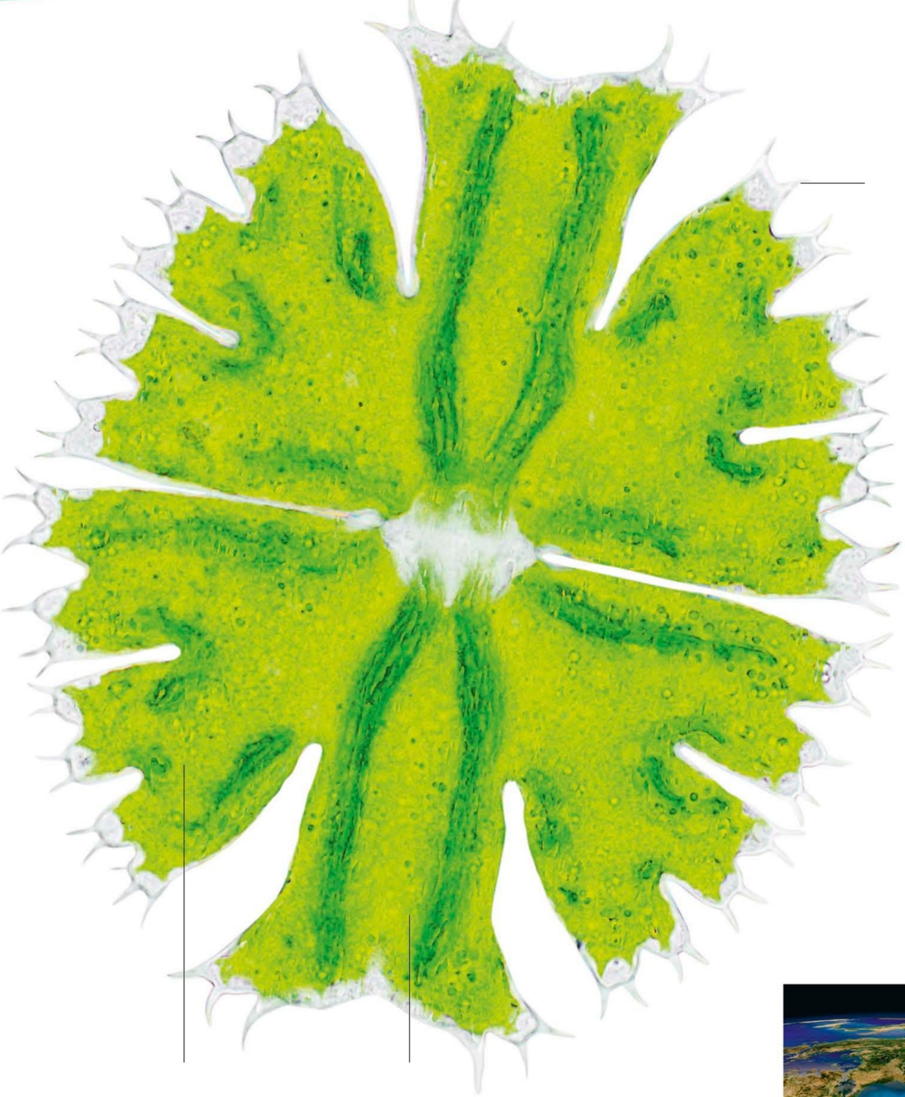












T

a

sp

th

g

A

h

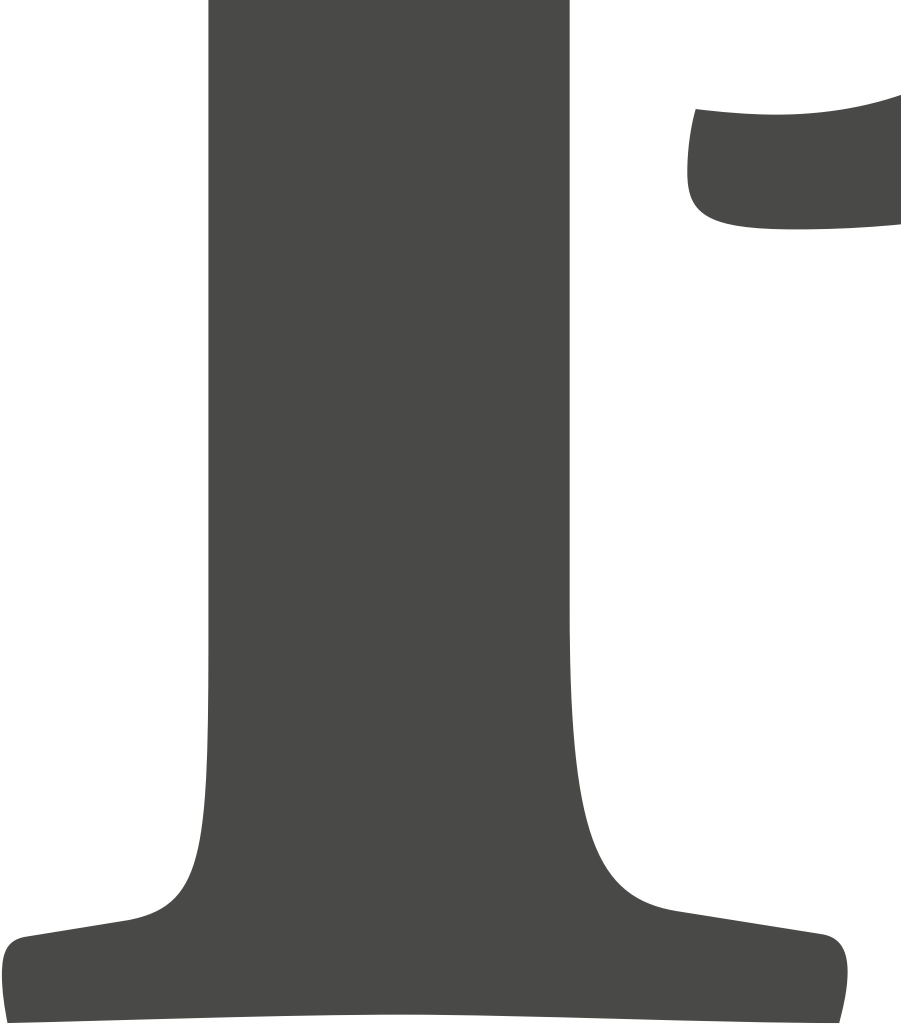
a

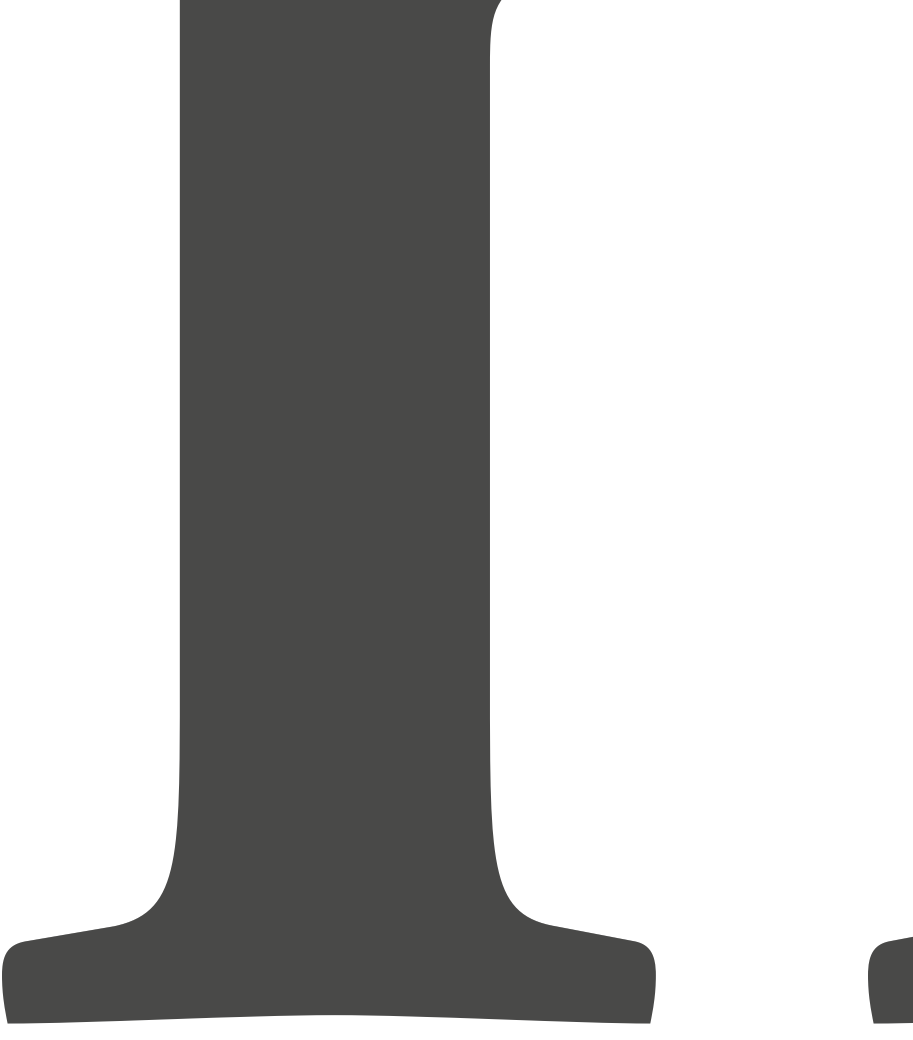
Ti

b

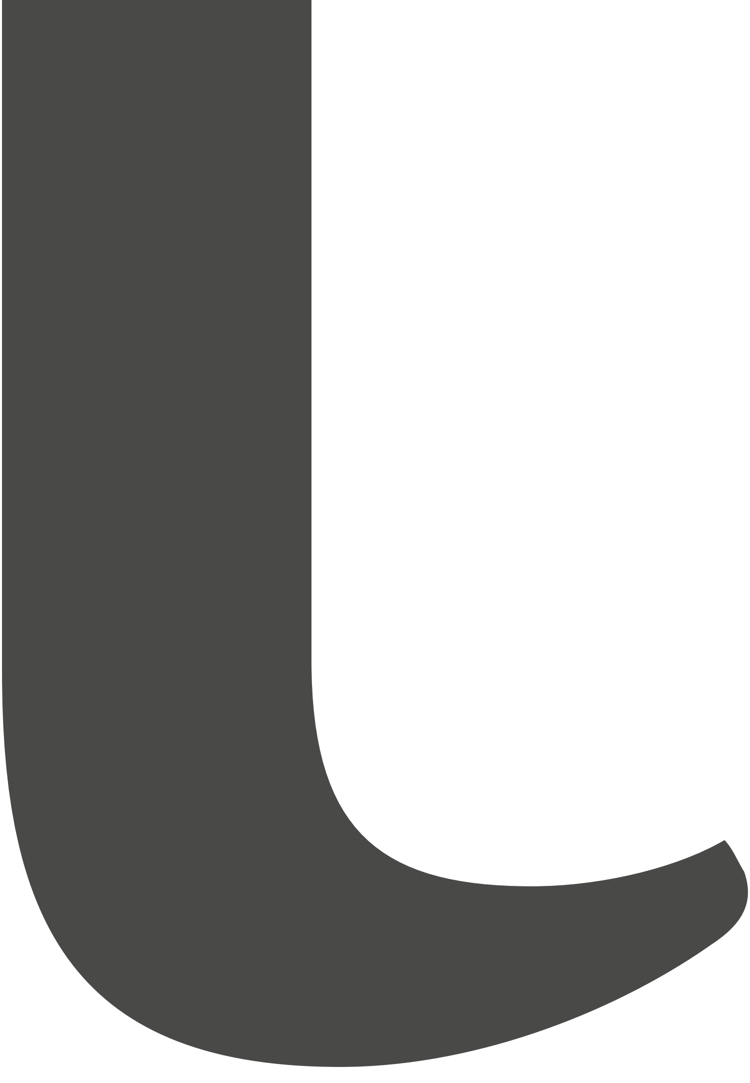
ul

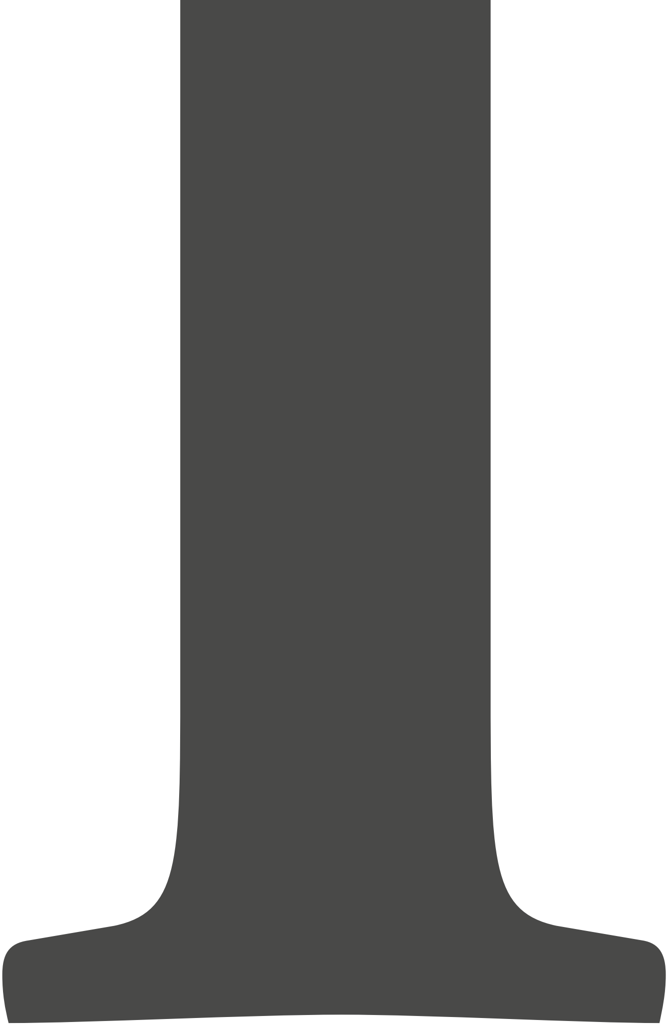
Vi



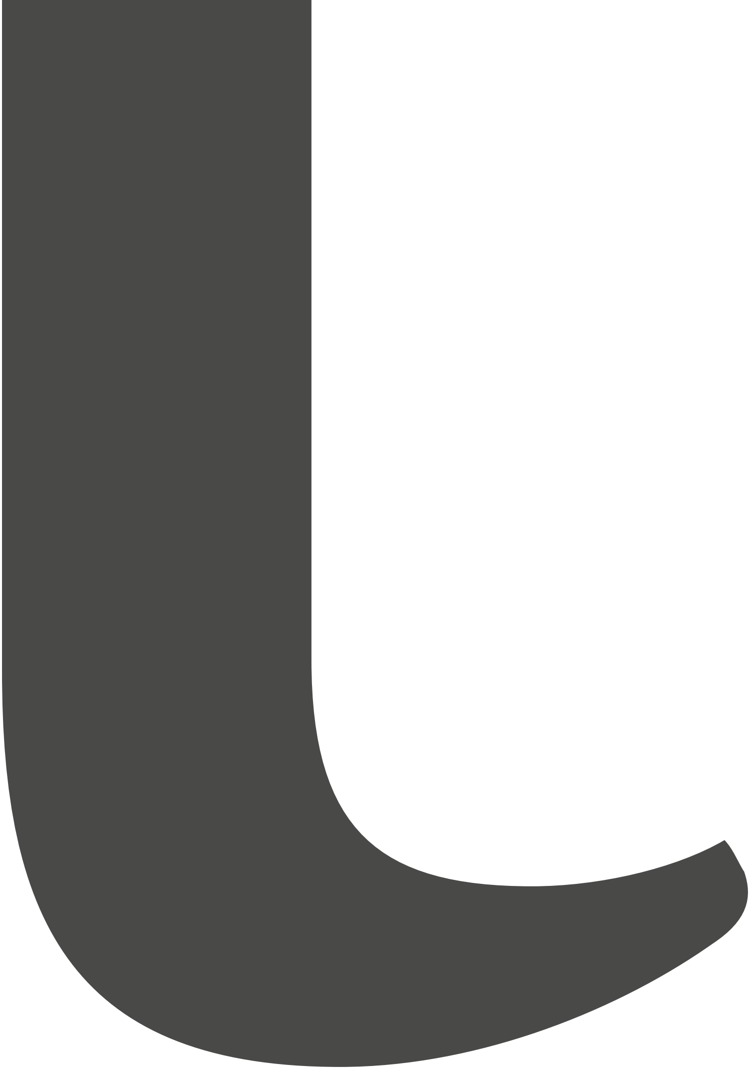


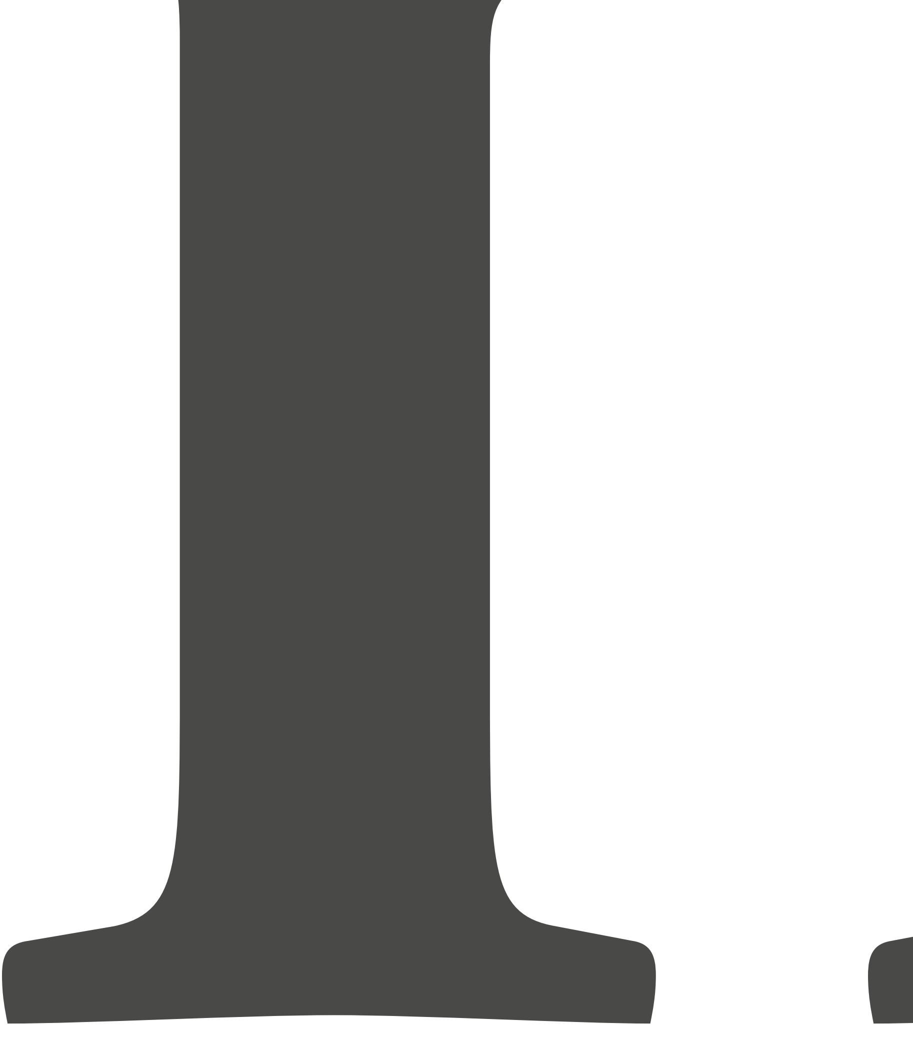
y



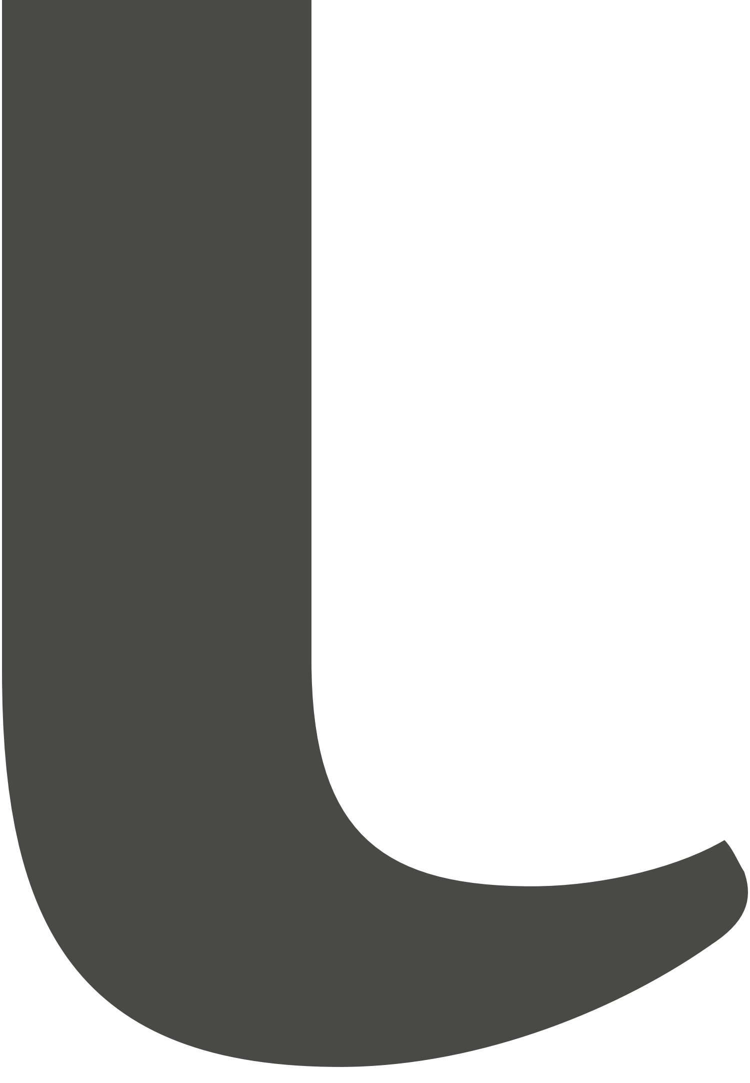


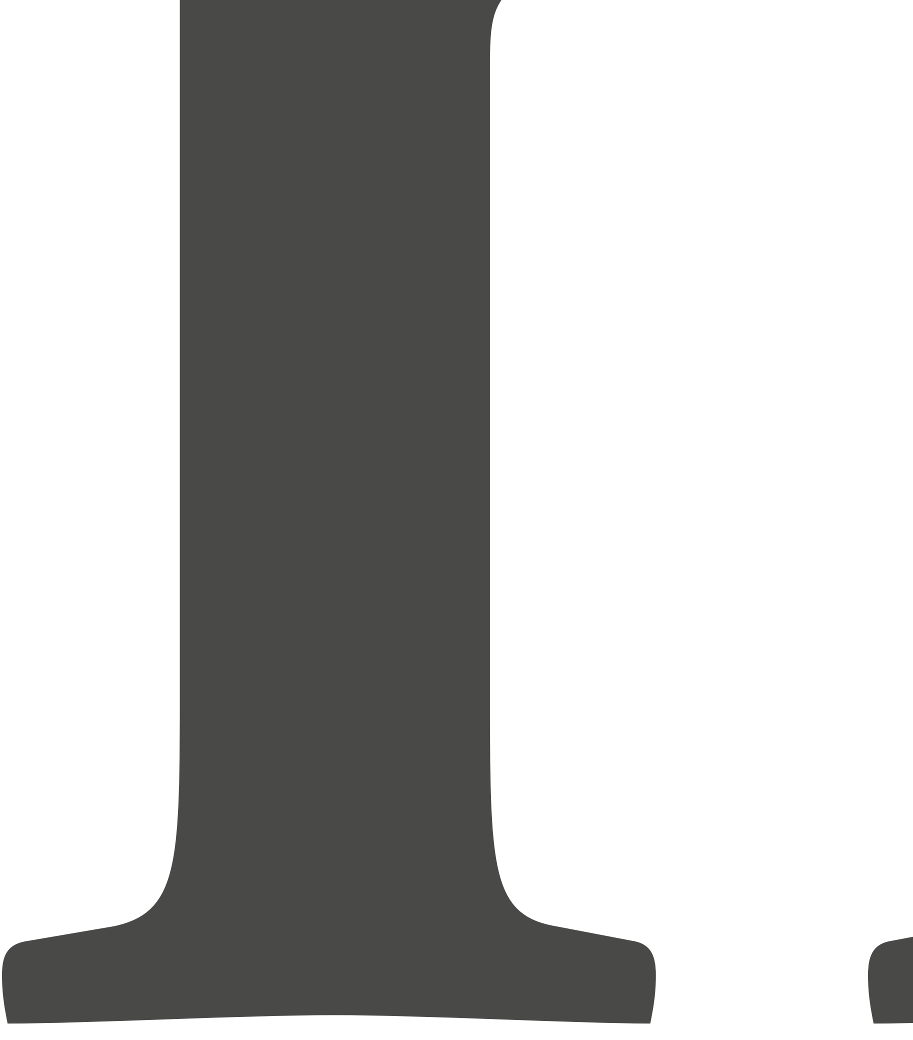
K

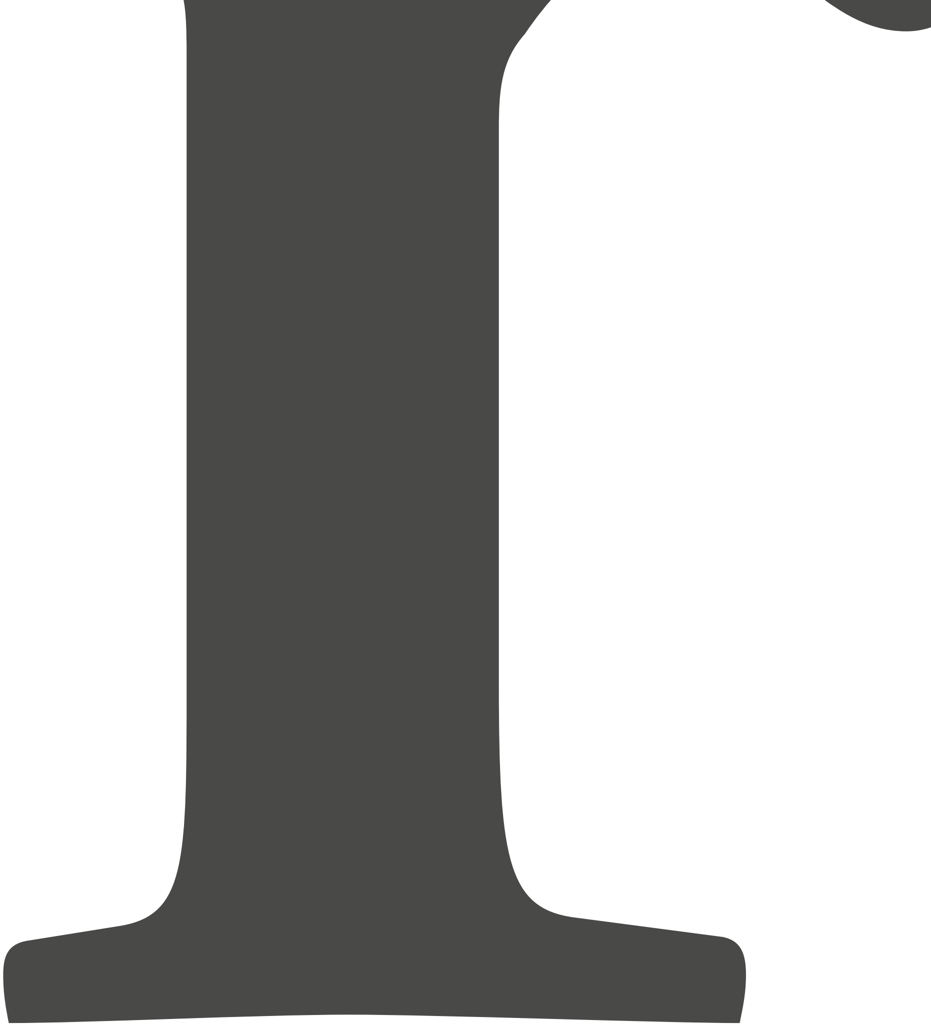


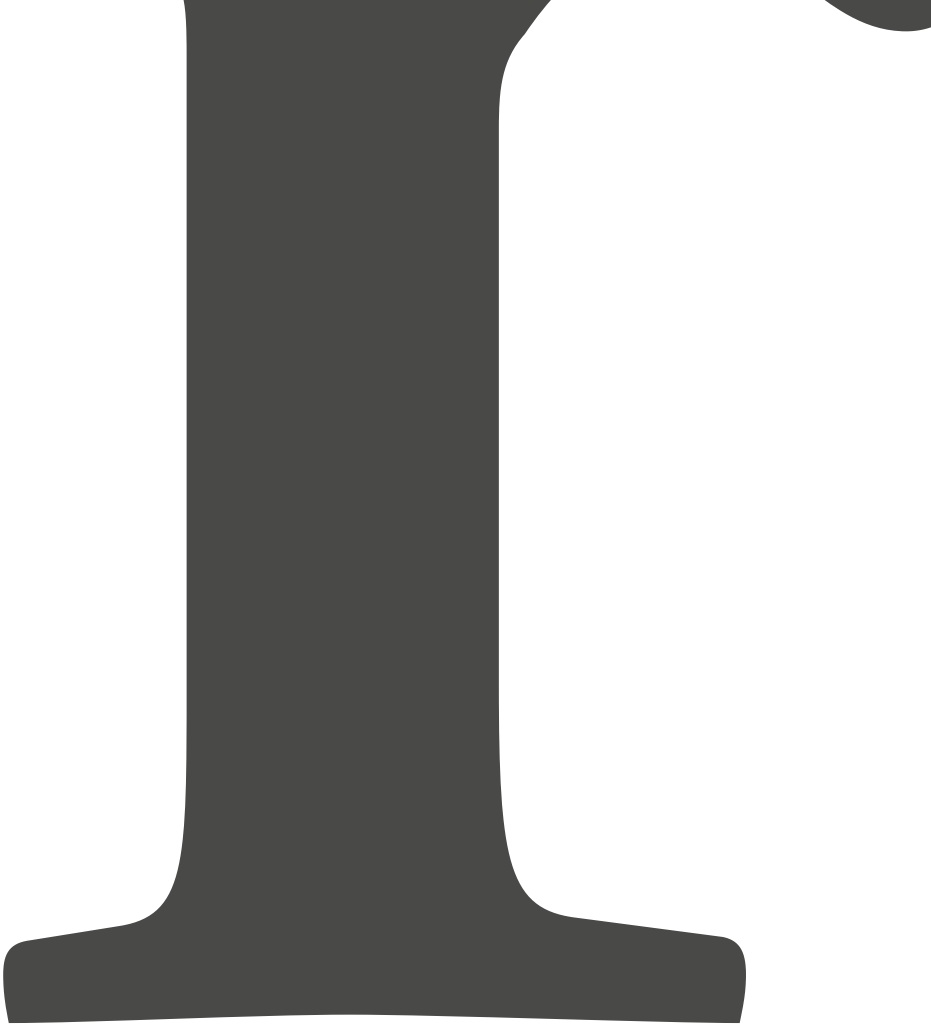


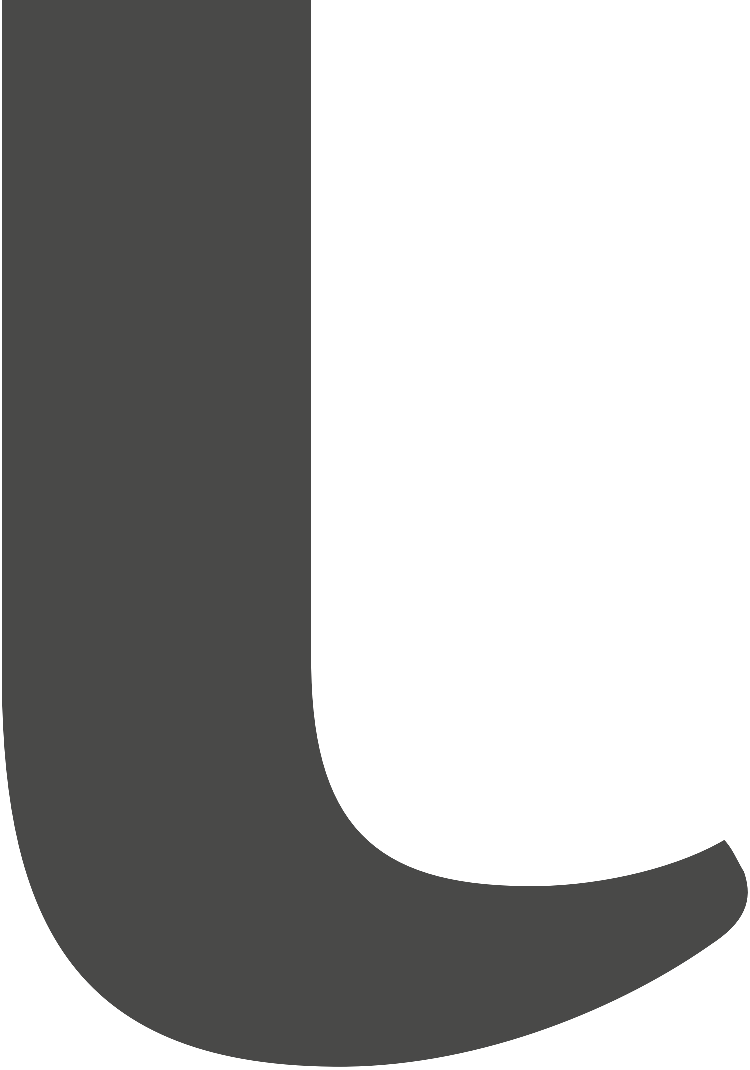
K

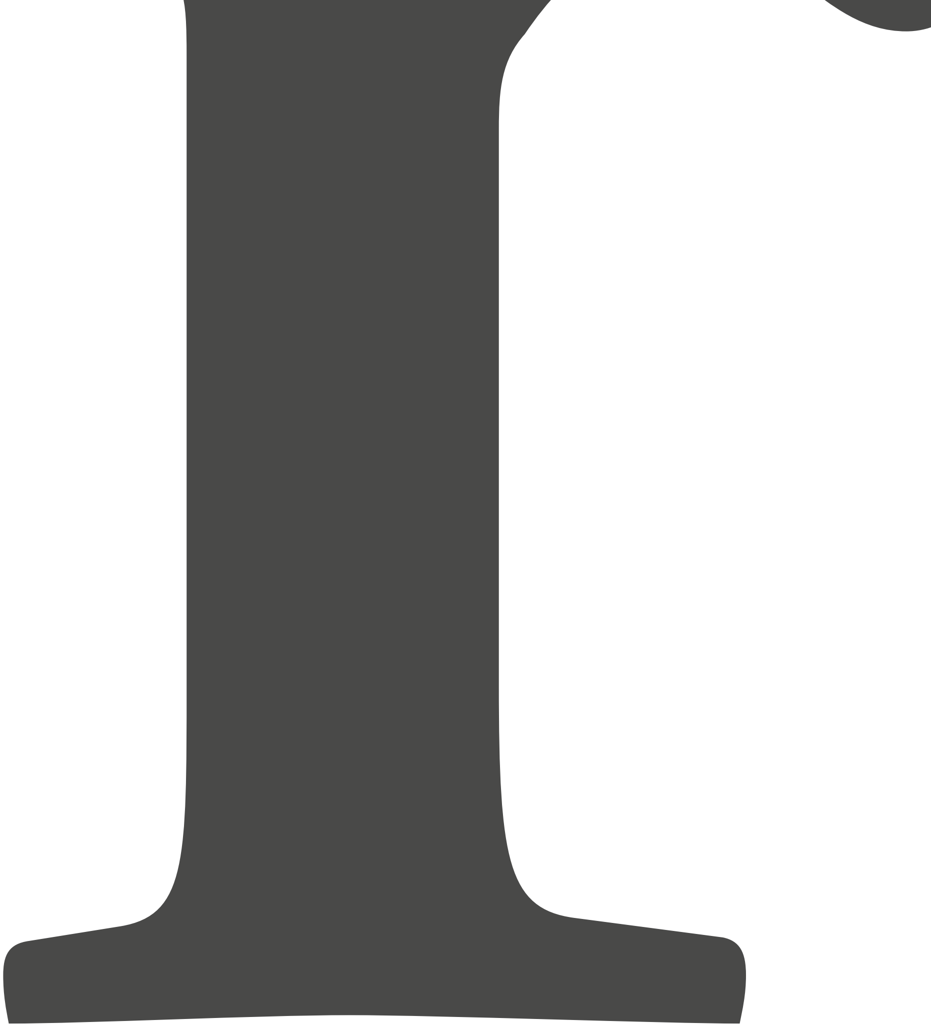






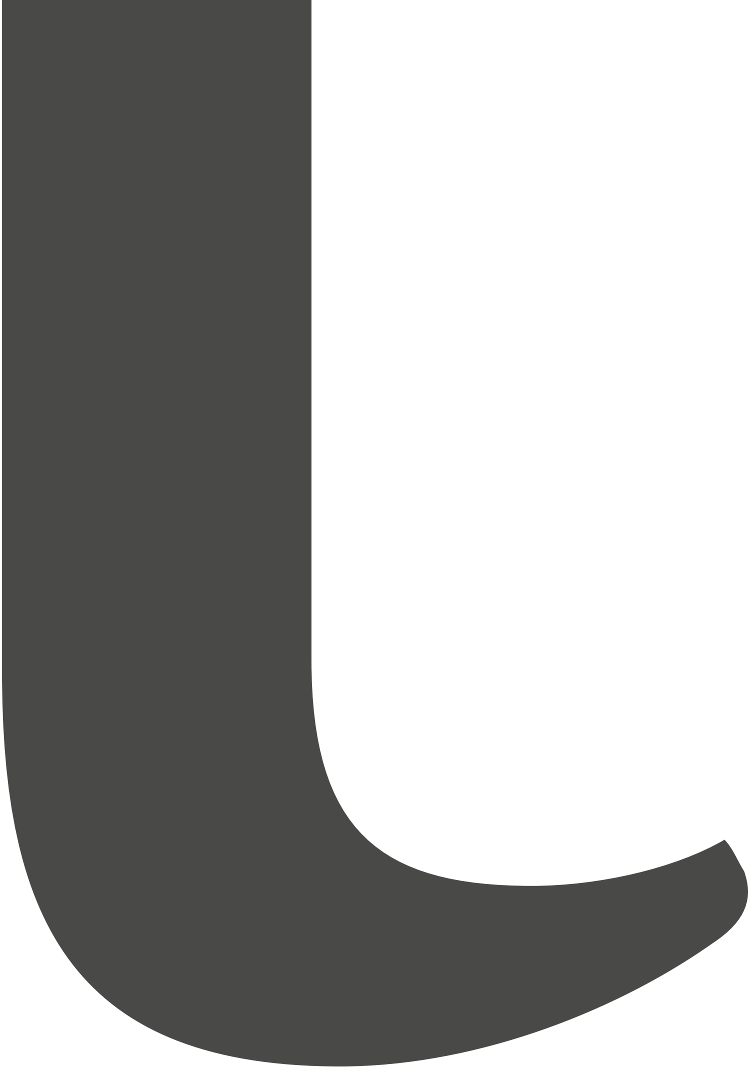


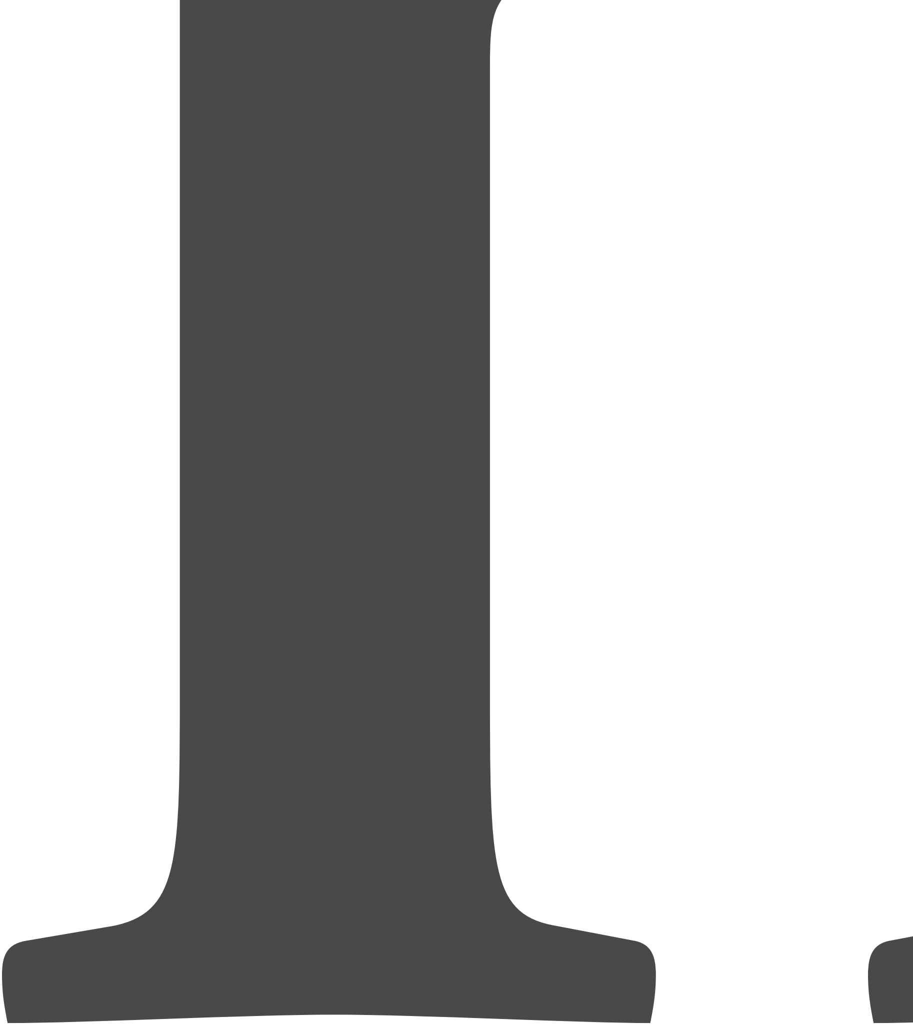




S

1



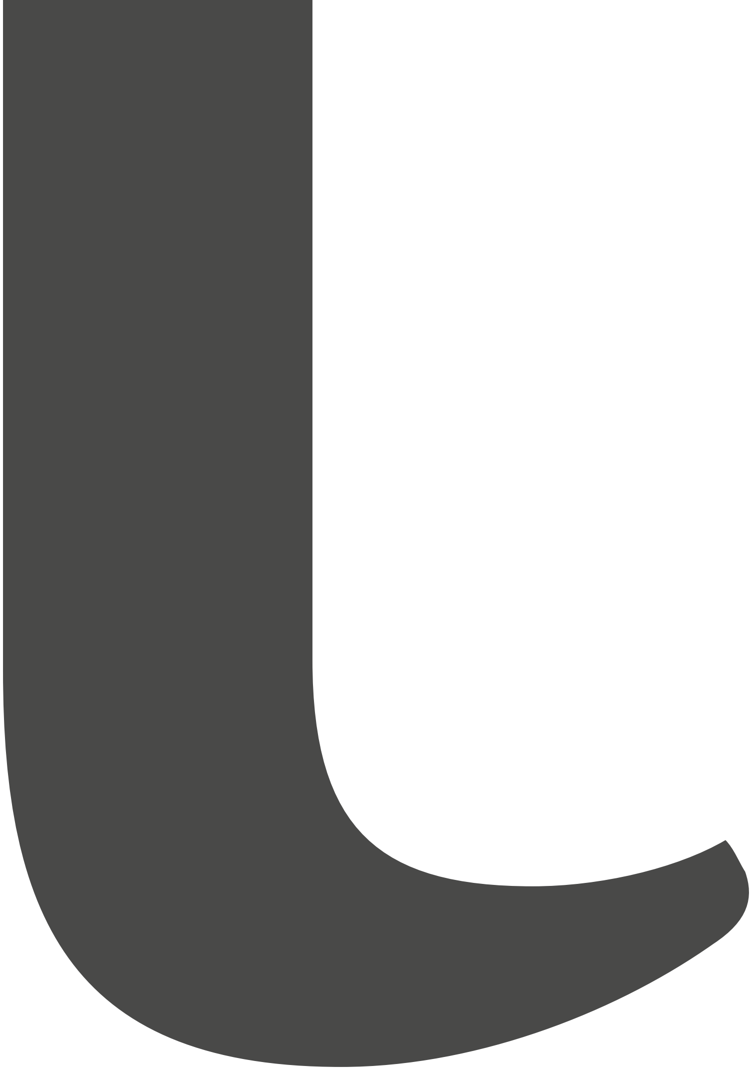


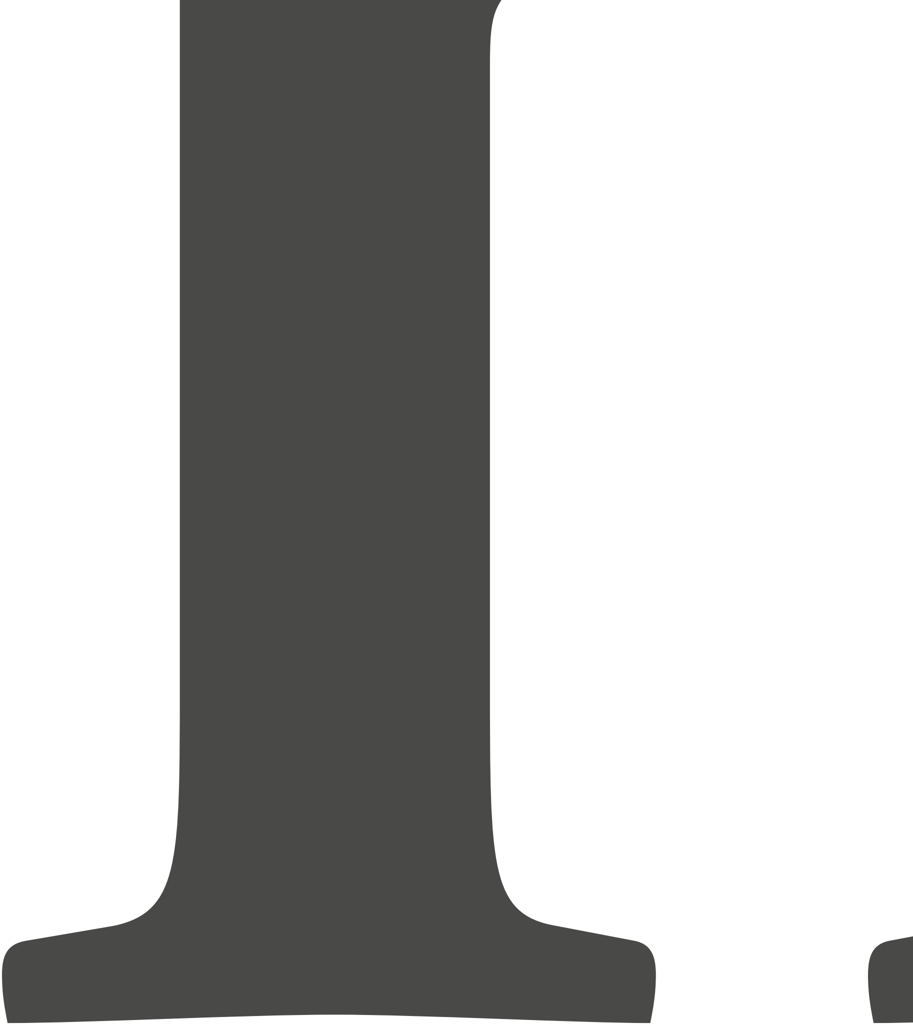
y

I

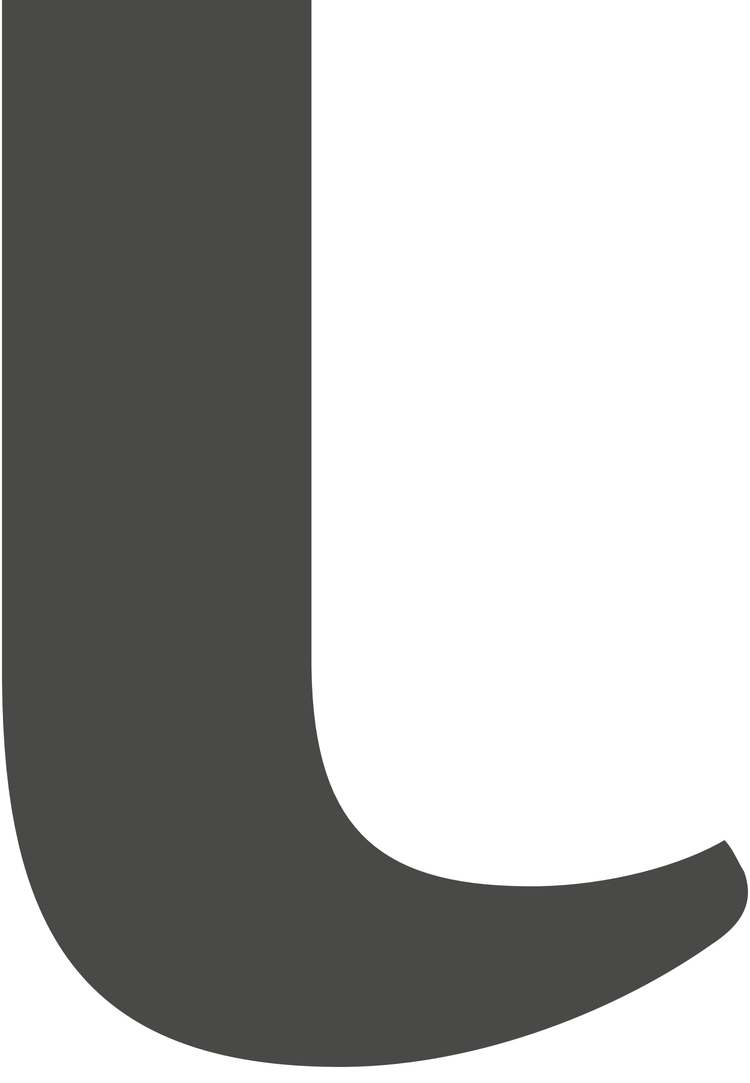
I

I



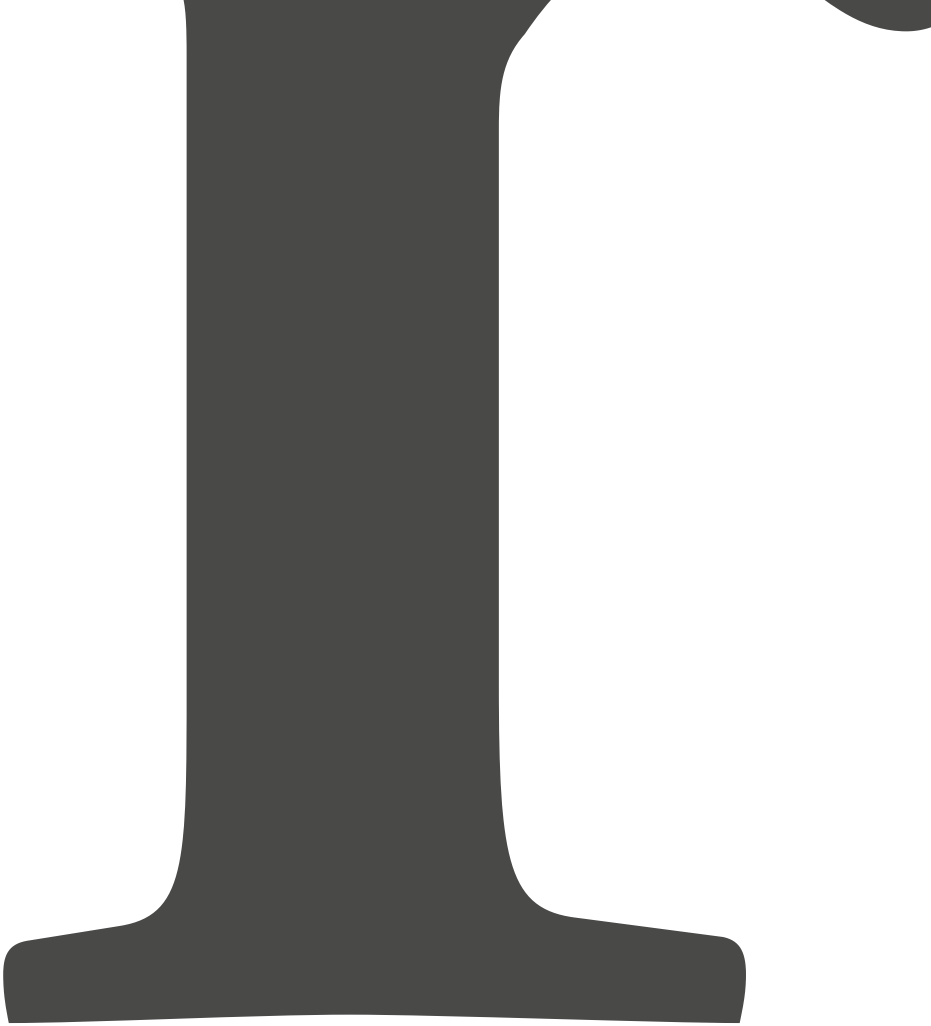


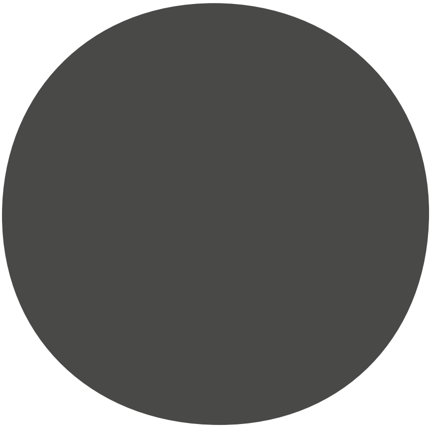
a



I

S





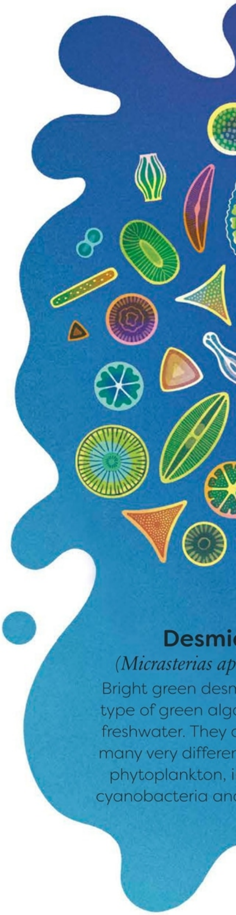
Li

d

g

ch

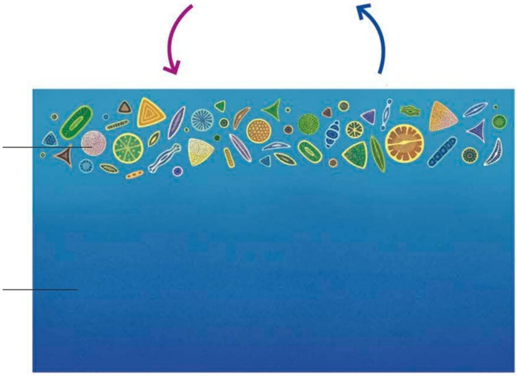
Phytoplankton



Desmi

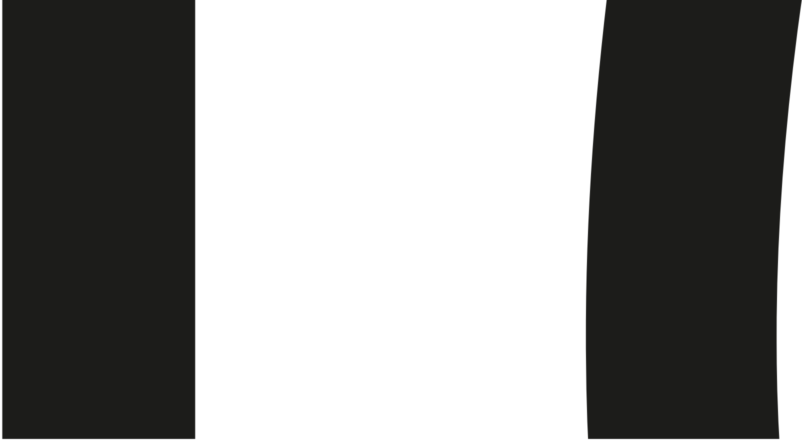
(Micrasterias ap

Bright green desm
type of green alg
freshwater. They
many very differe
phytoplankton, i
cyanobacteria and



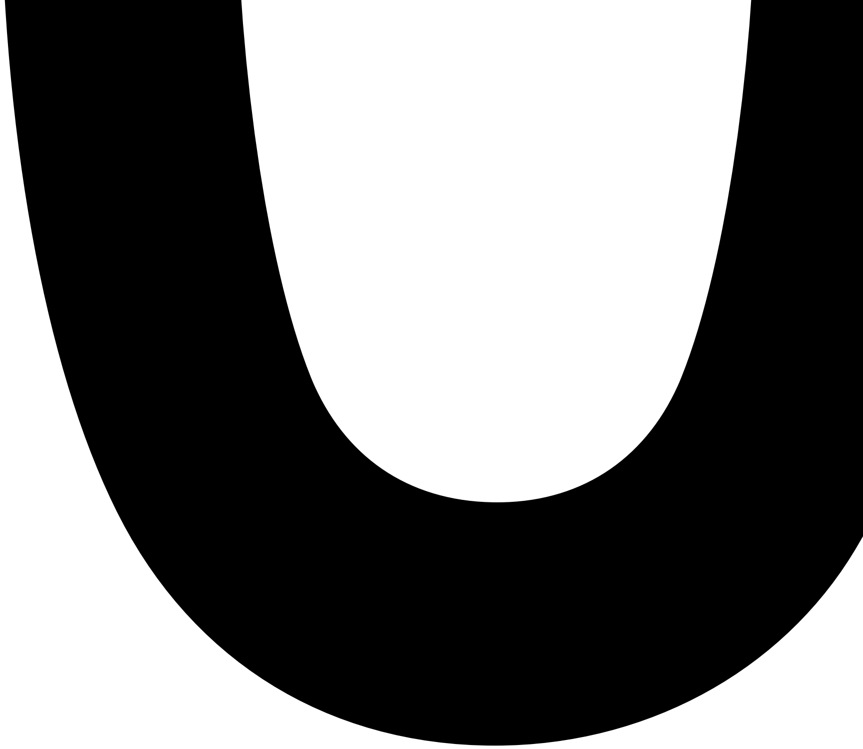
Ocean oxygen

Life in the ocean depends on phytoplankton, which take in carbon dioxide and give off oxygen. The oxygen is used by all sorts of animals, including air-breathing whales. In turn, whale poo contains nitrogen and iron, which help the phytoplankton grow.



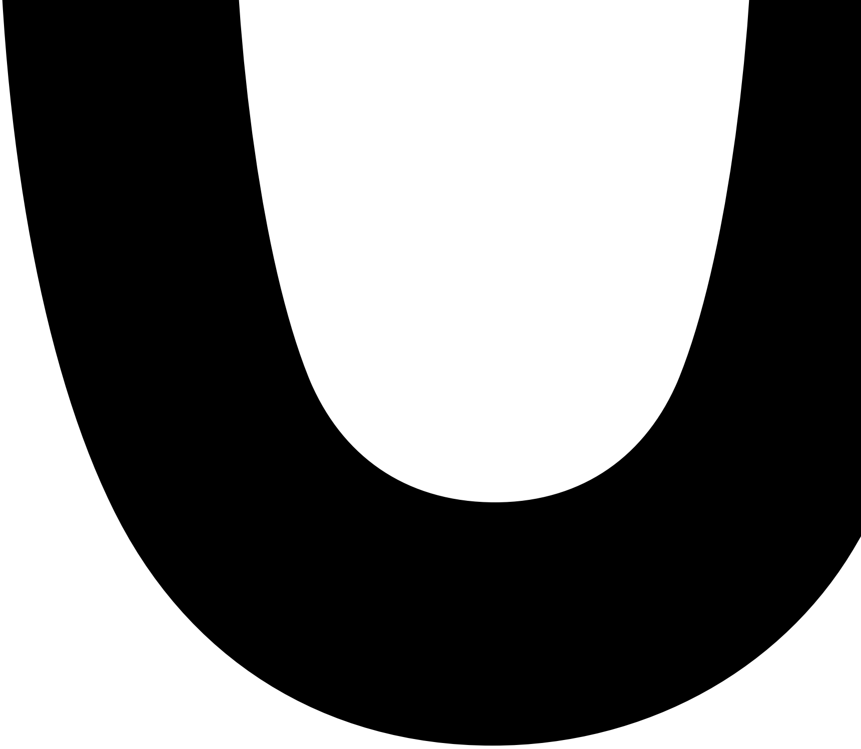
[redacted]

[redacted]



[redacted]

[redacted]



Li

p

C

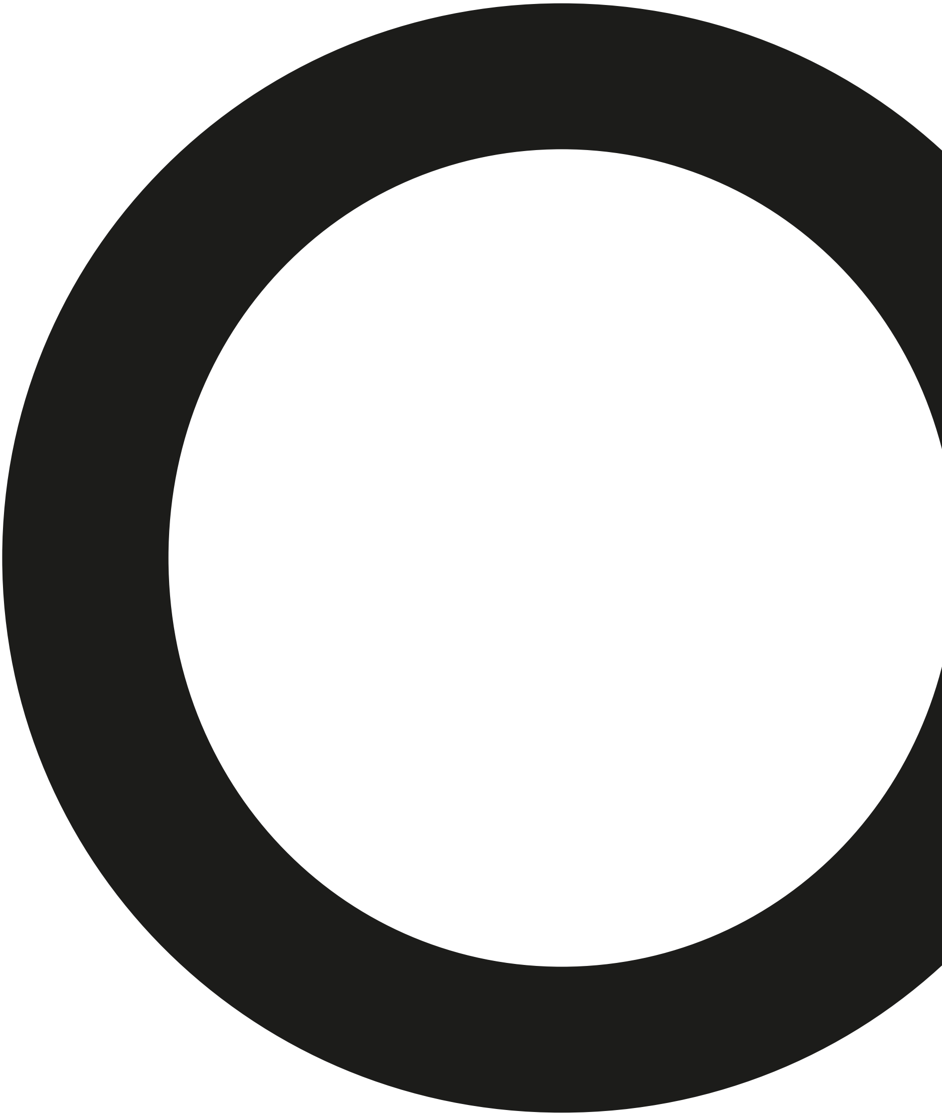
T

a

W

n

p

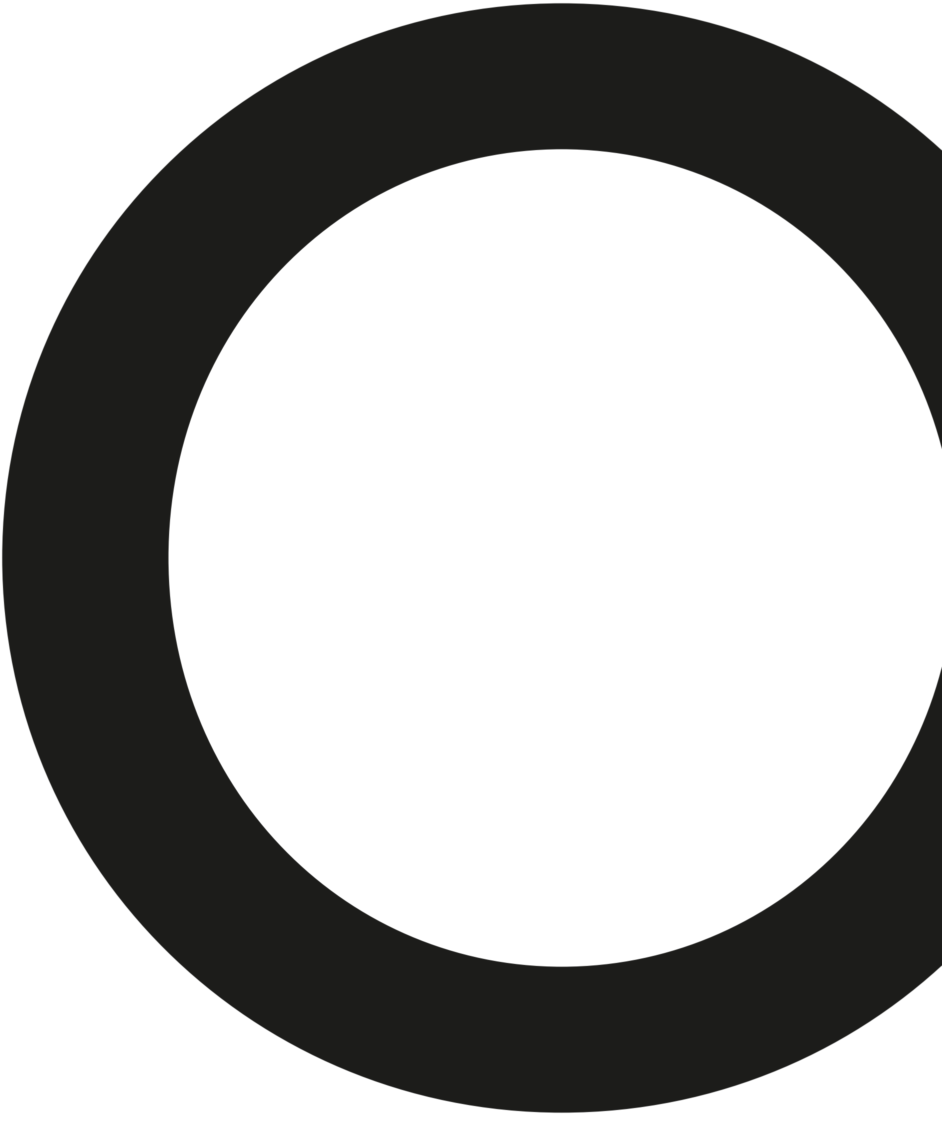


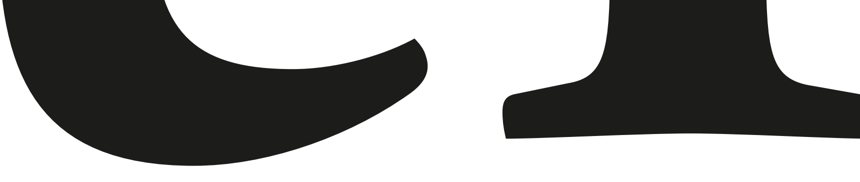
re

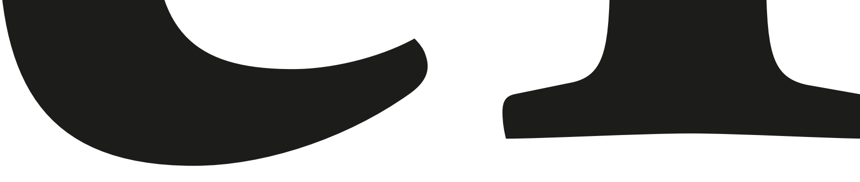
C

a

P







([illegible]

B

ty

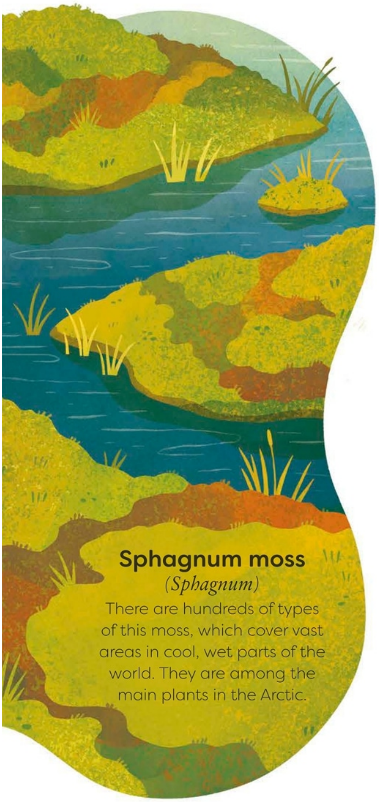
fr

m

p

C

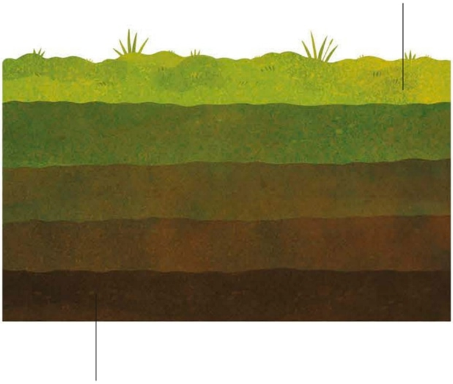
Sphagnum moss



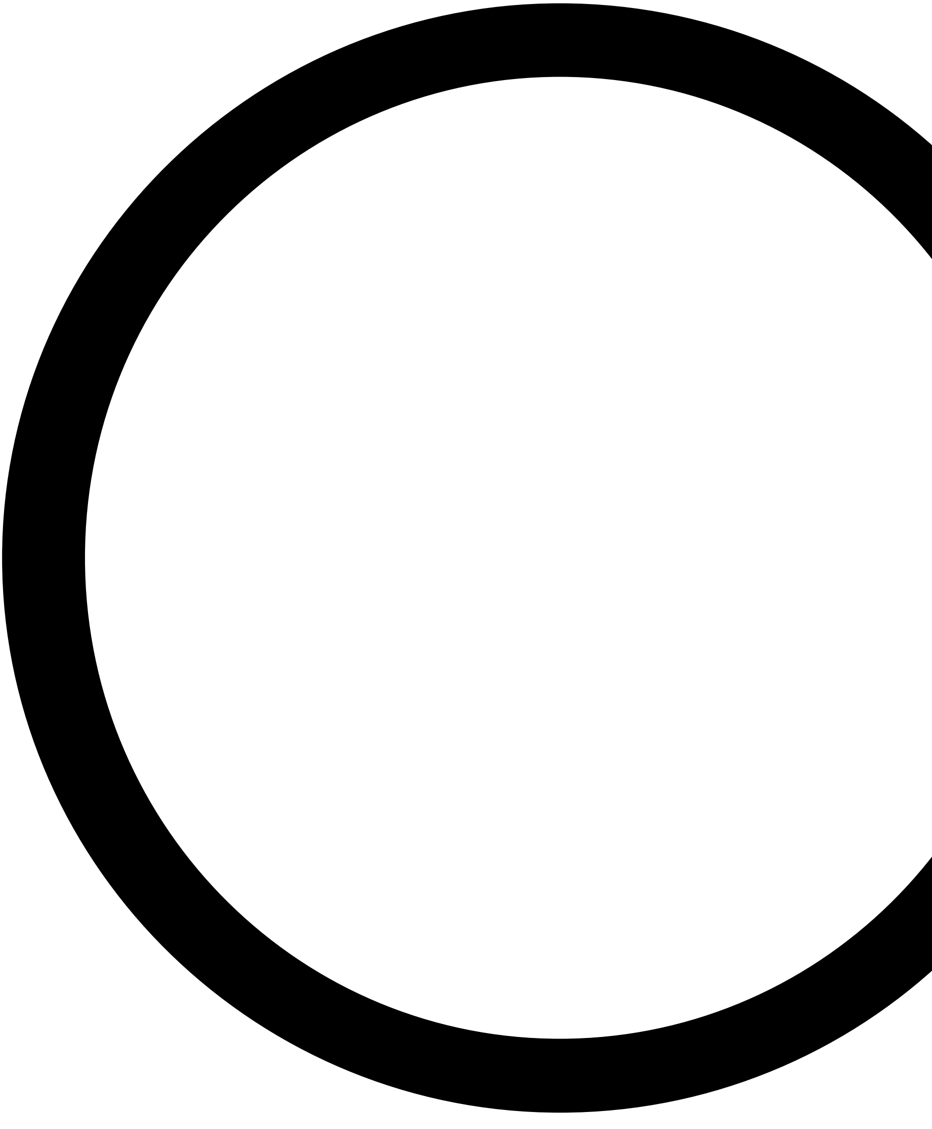
Sphagnum moss
(Sphagnum)
There are hundreds of types of this moss, which cover vast areas in cool, wet parts of the world. They are among the main plants in the Arctic.

Making peat

Over thousands of years, dead sphagnum moss slowly piles up. The plant material underneath is squashed down and eventually it turns into a rich soil called peat. Just 0.04 in (1 mm) of peat forms each year. Peat is dug up to grow plants in, but because it stores so much carbon, it is best left in bogs!



10



sp

p

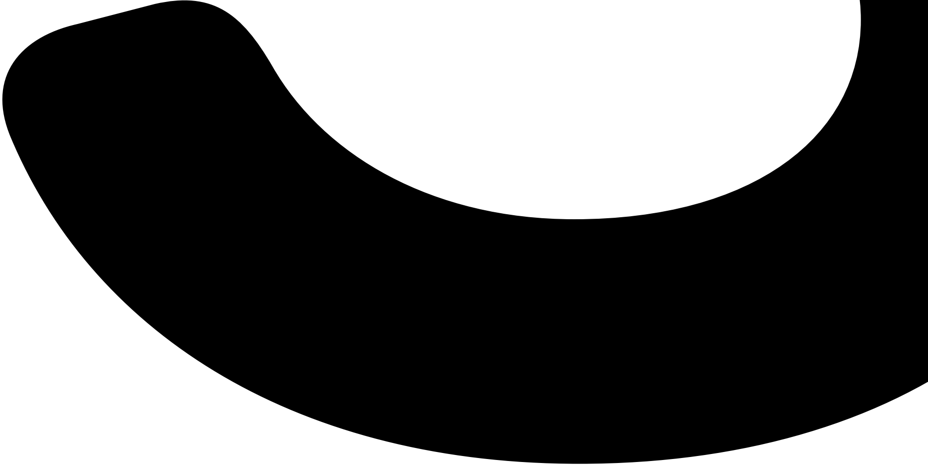
d

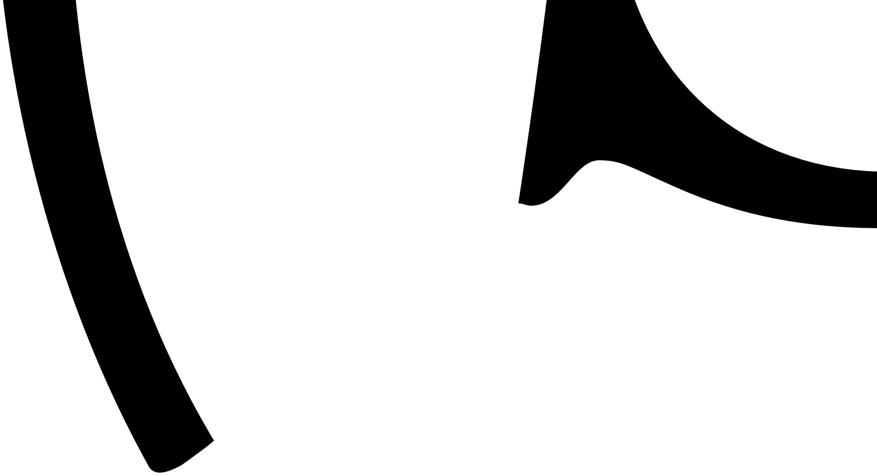
S

p

g

m





T

O

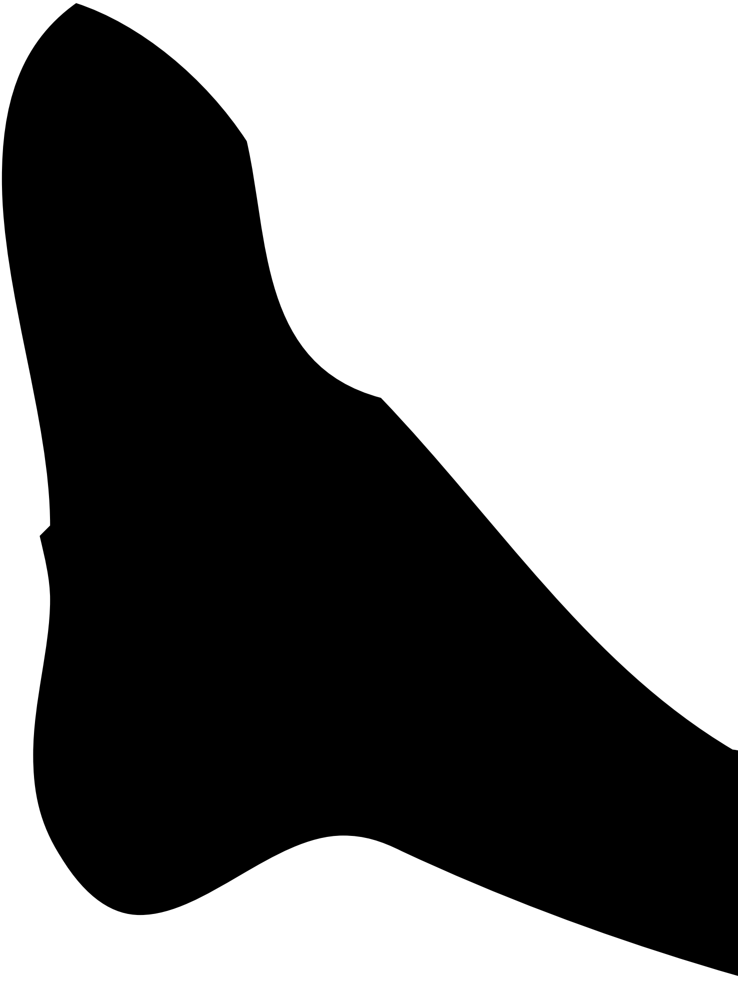
a

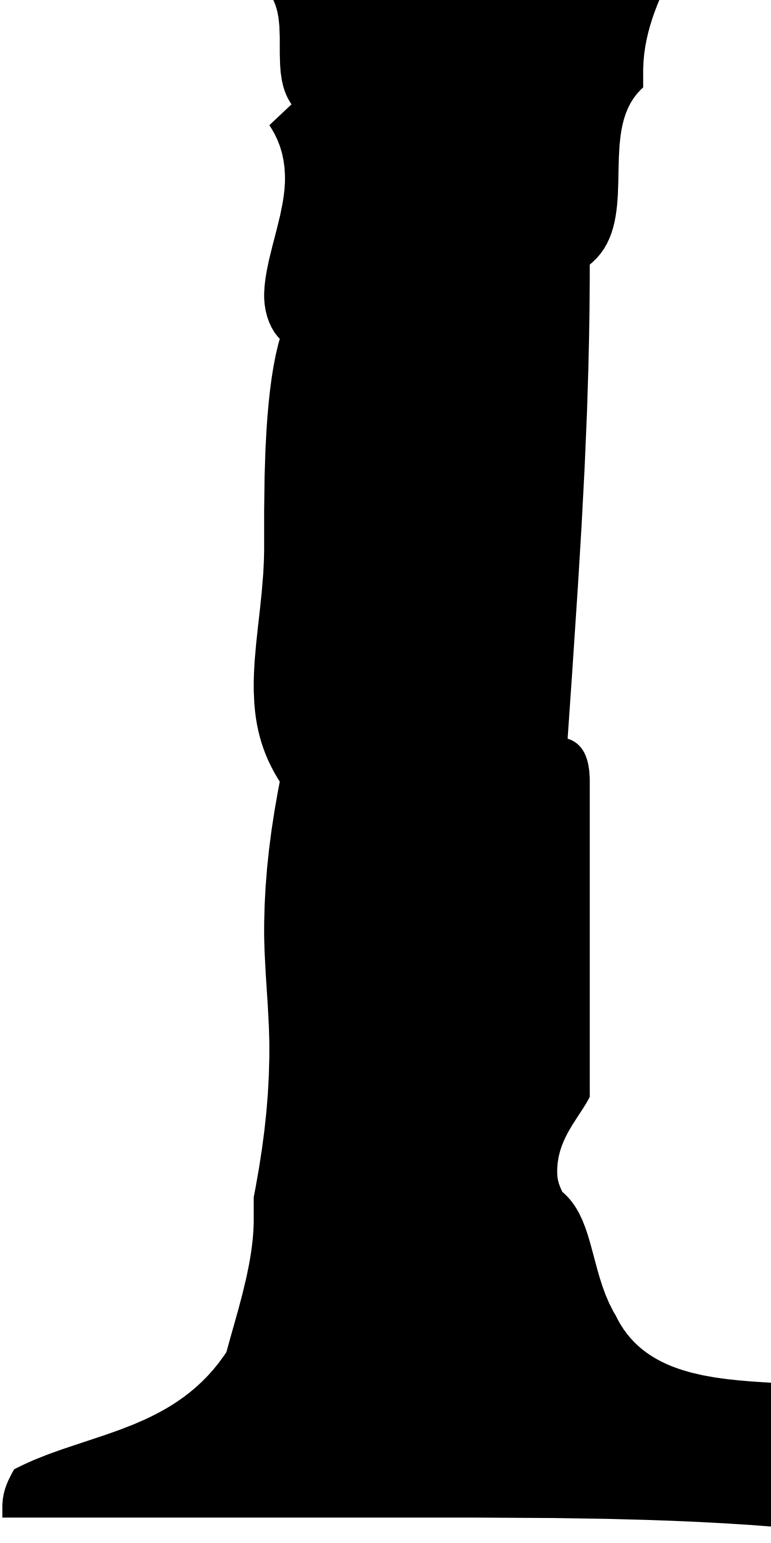
w

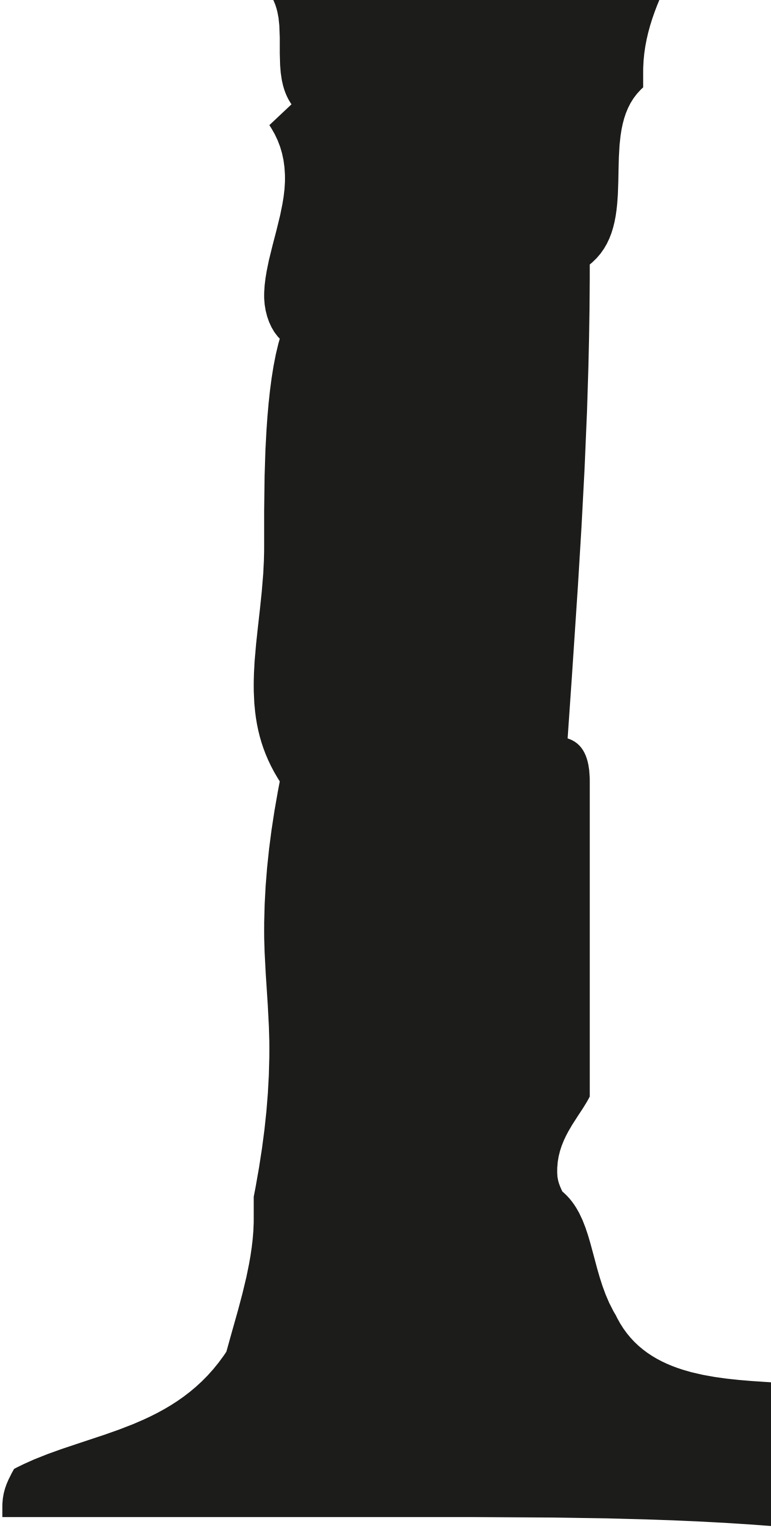
m

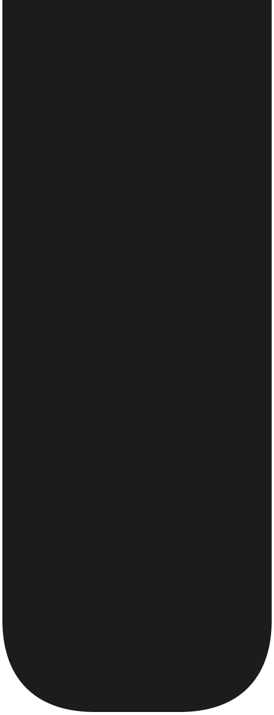
M

P

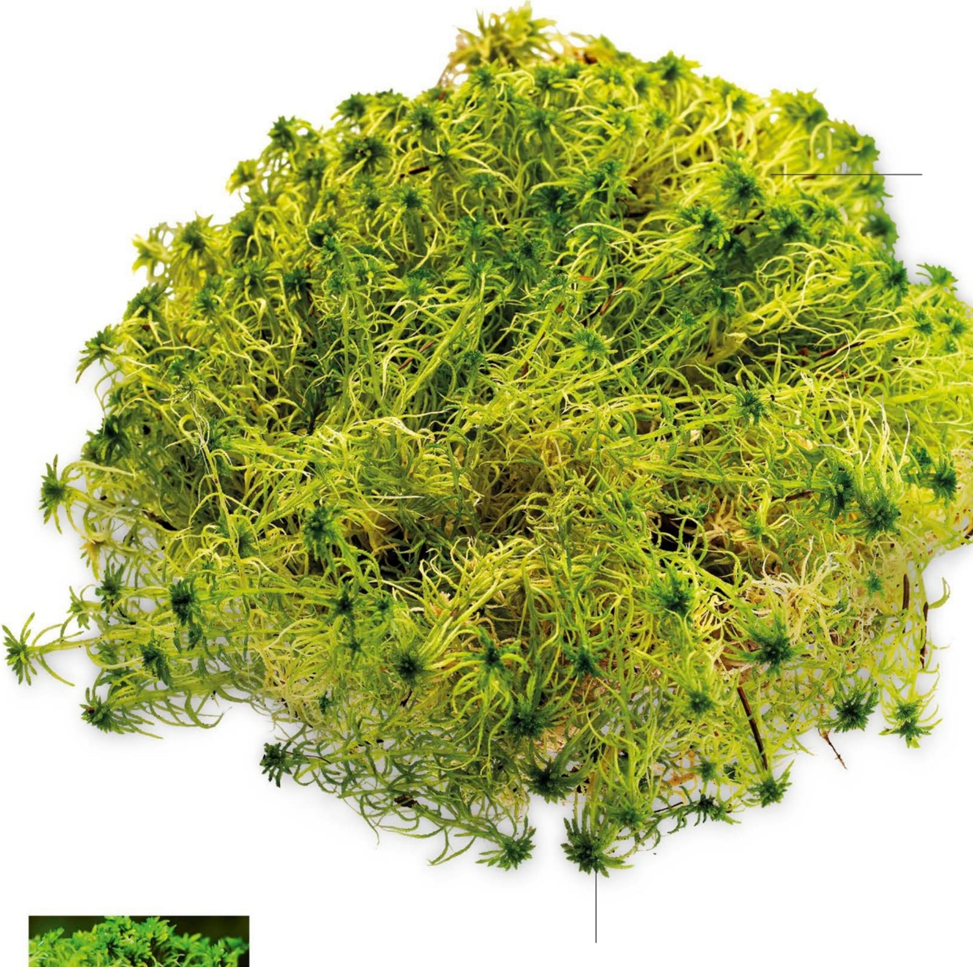








V

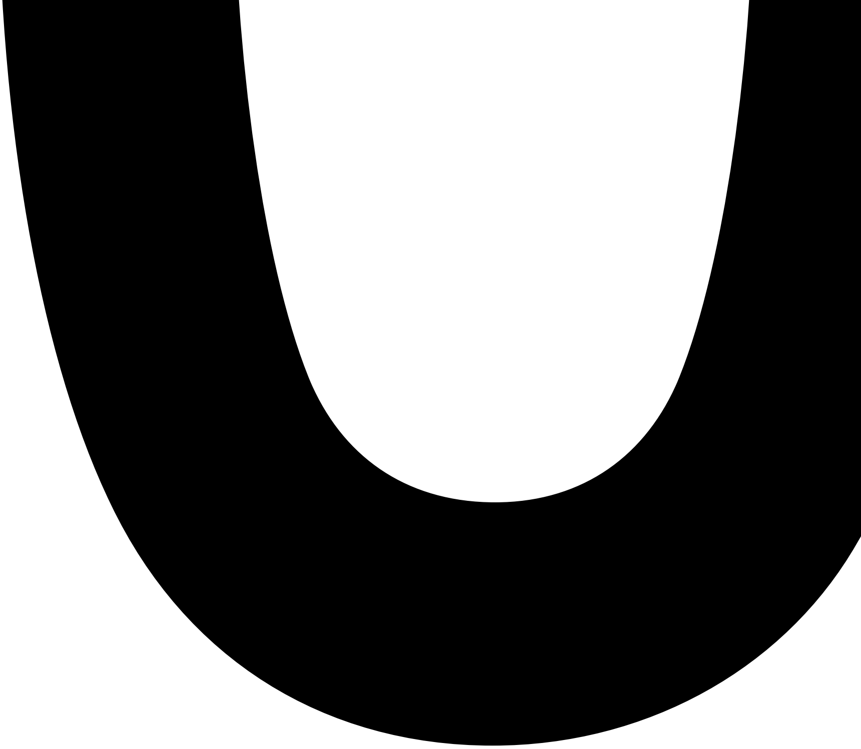


G

U

IV

IV



T

m

th

d

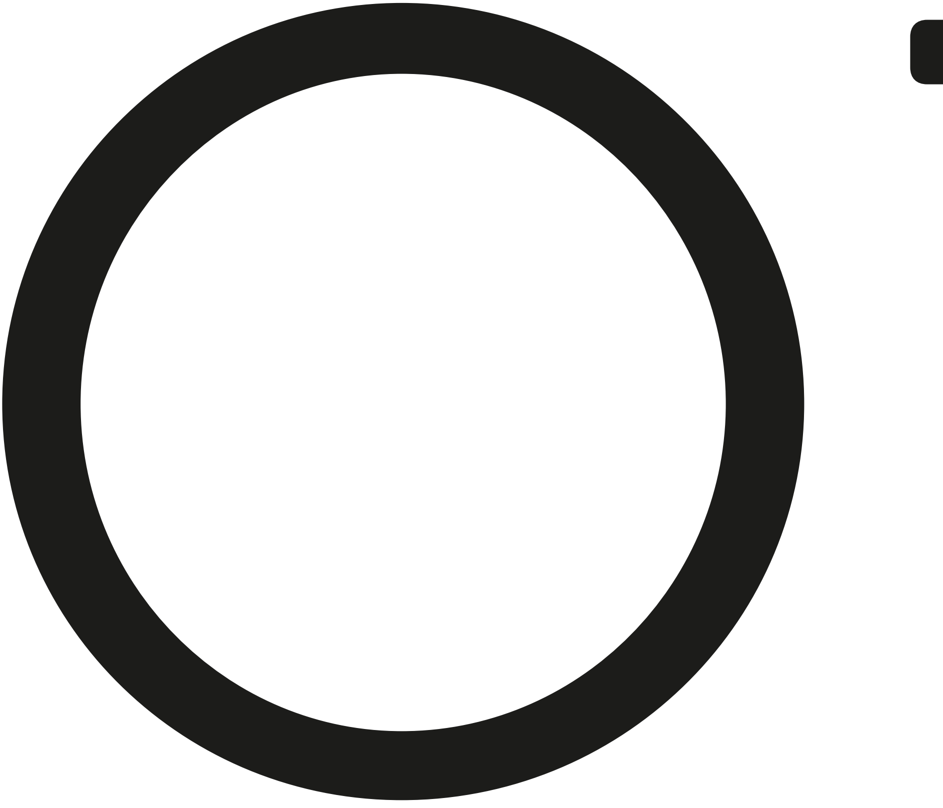
m

T

le

O

S



t

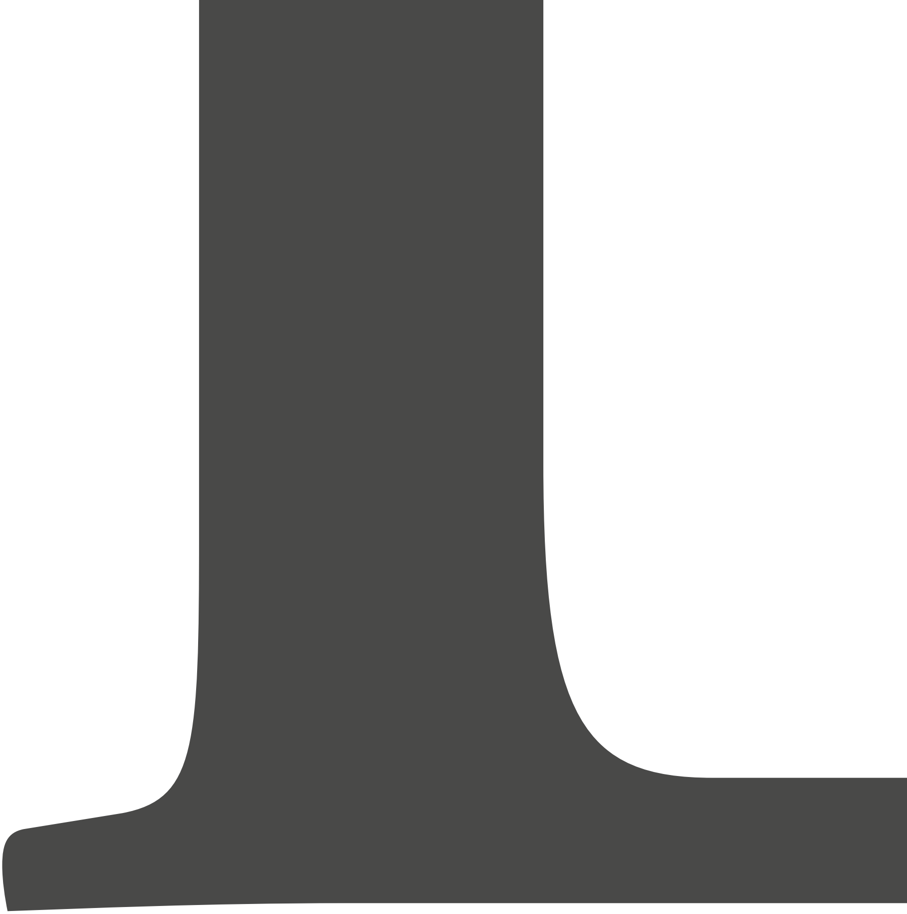
a

a

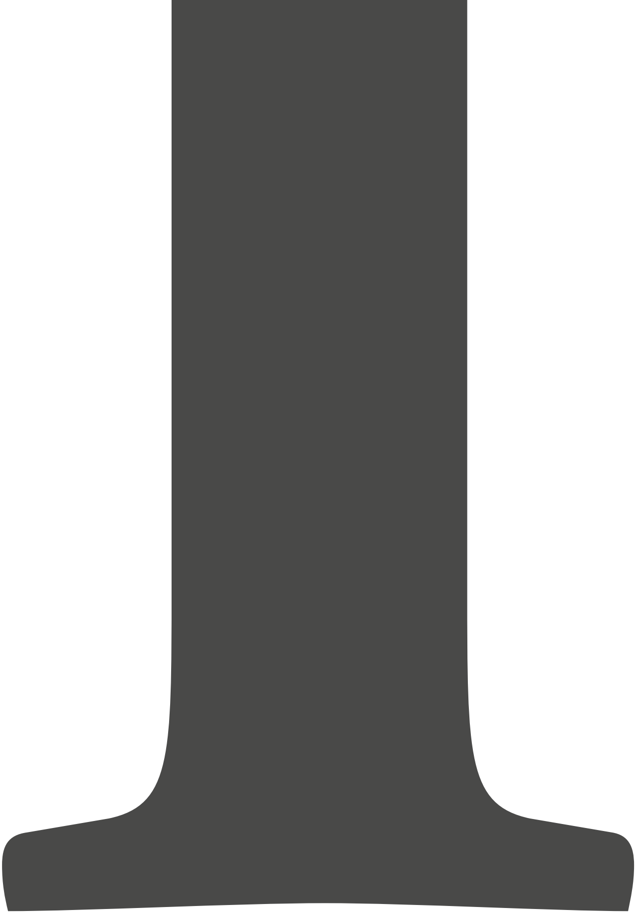
F

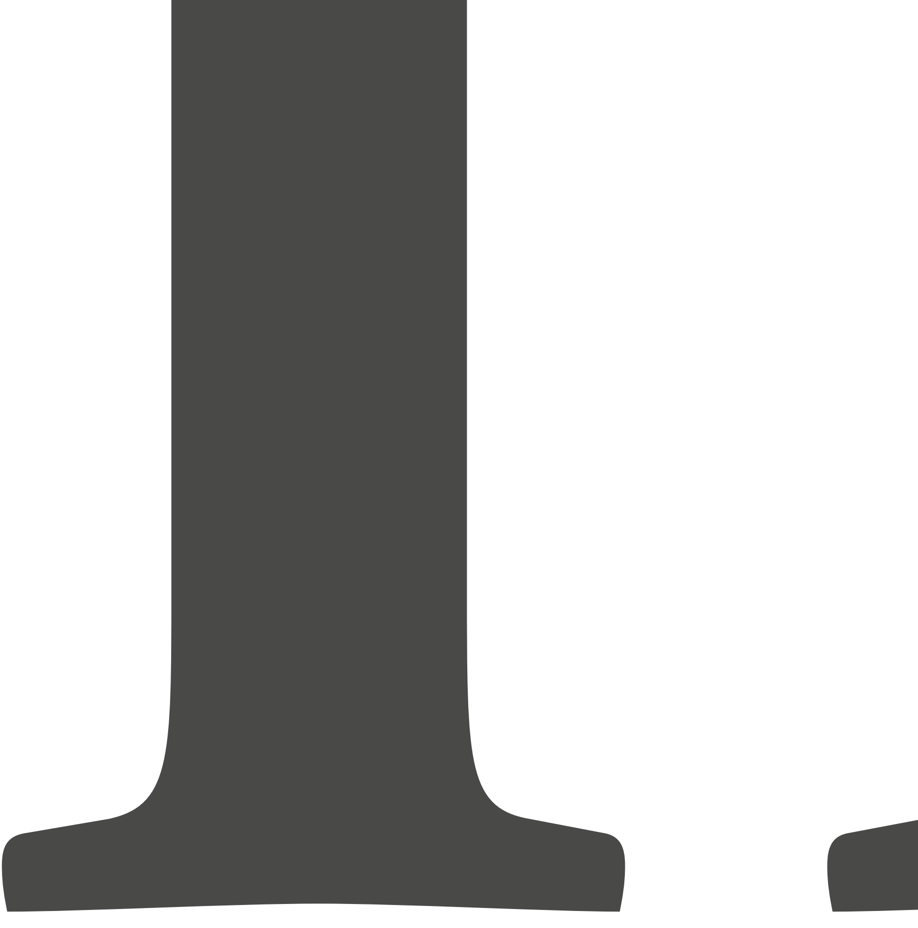
in

a

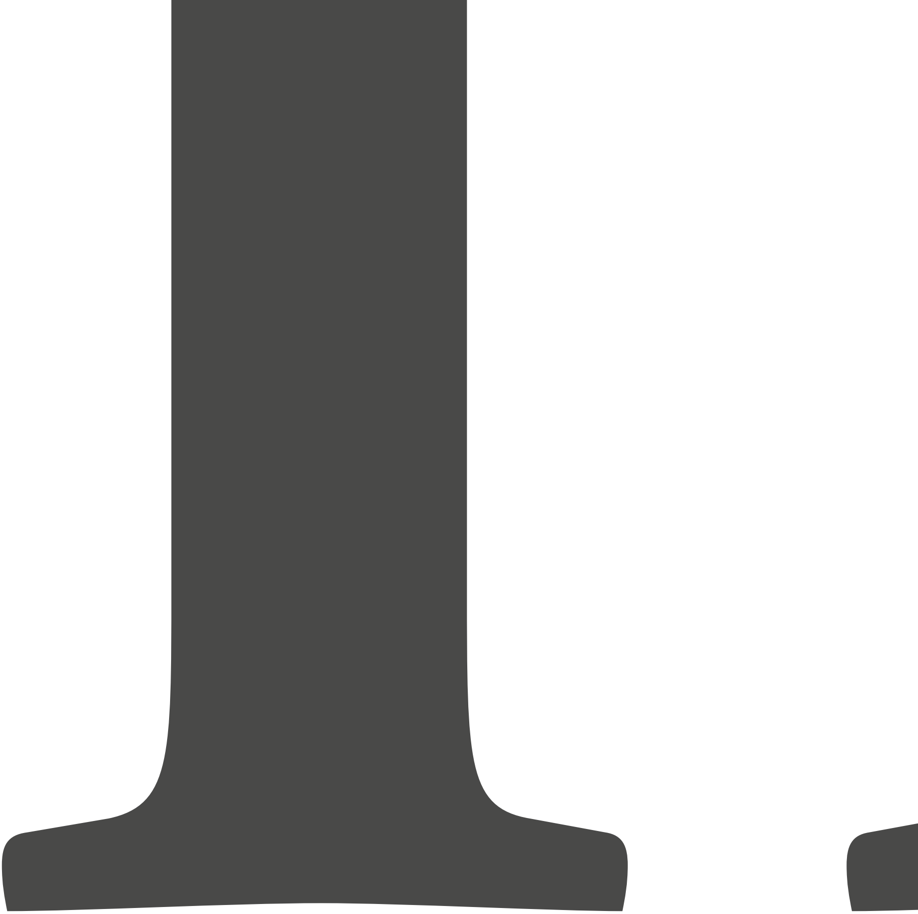


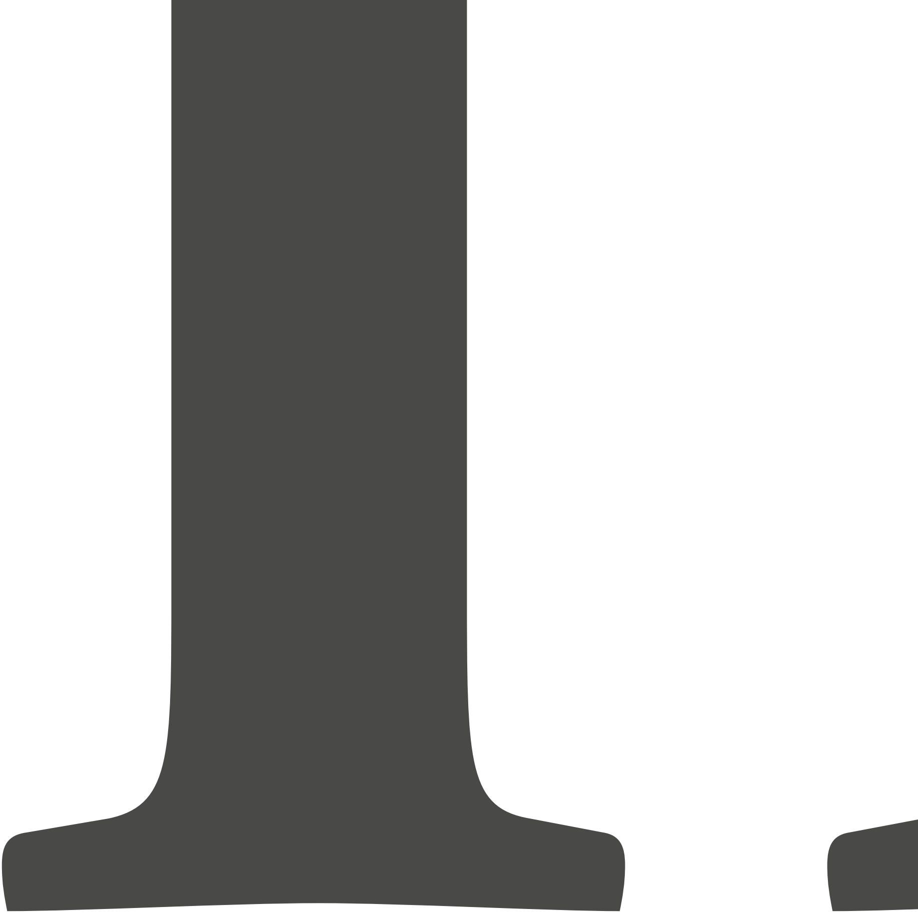
1





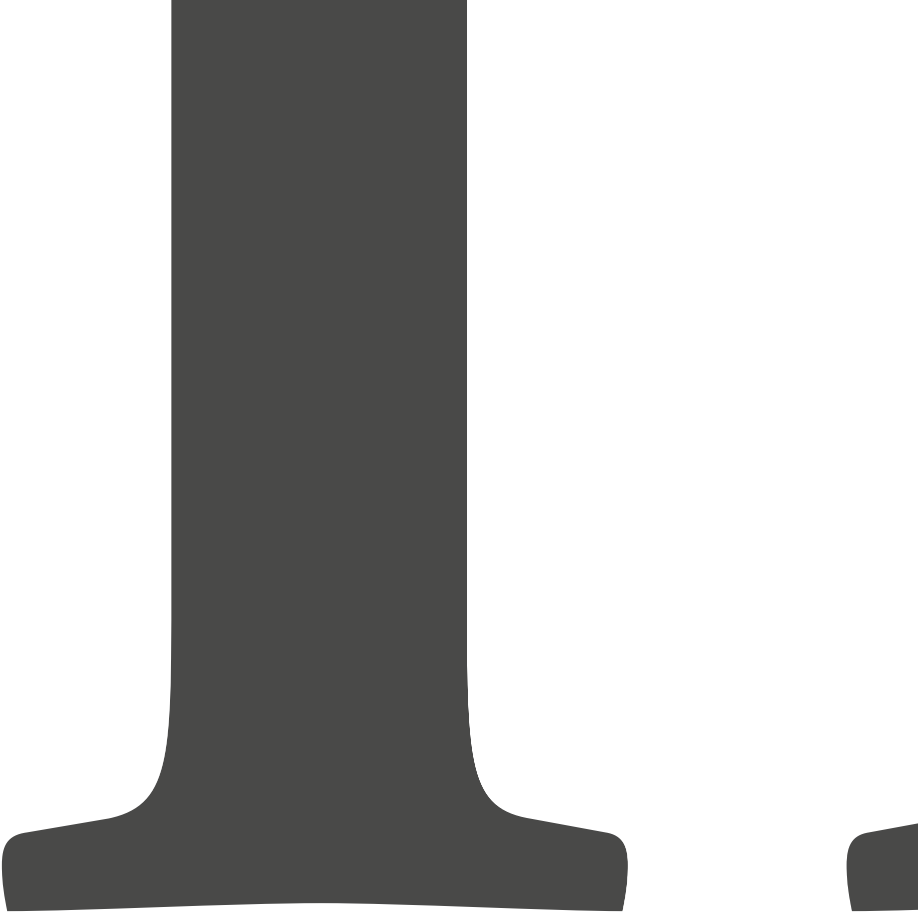
g

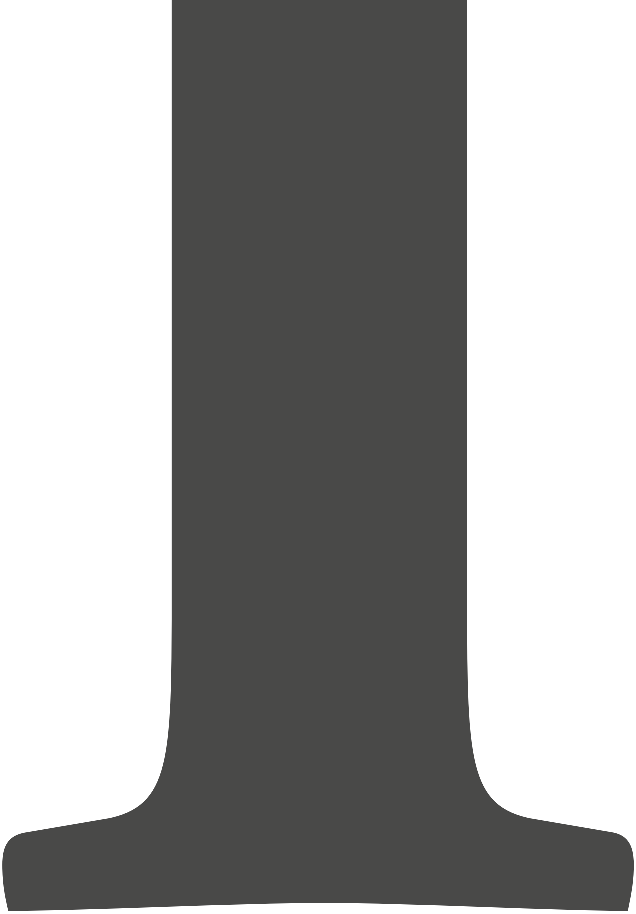


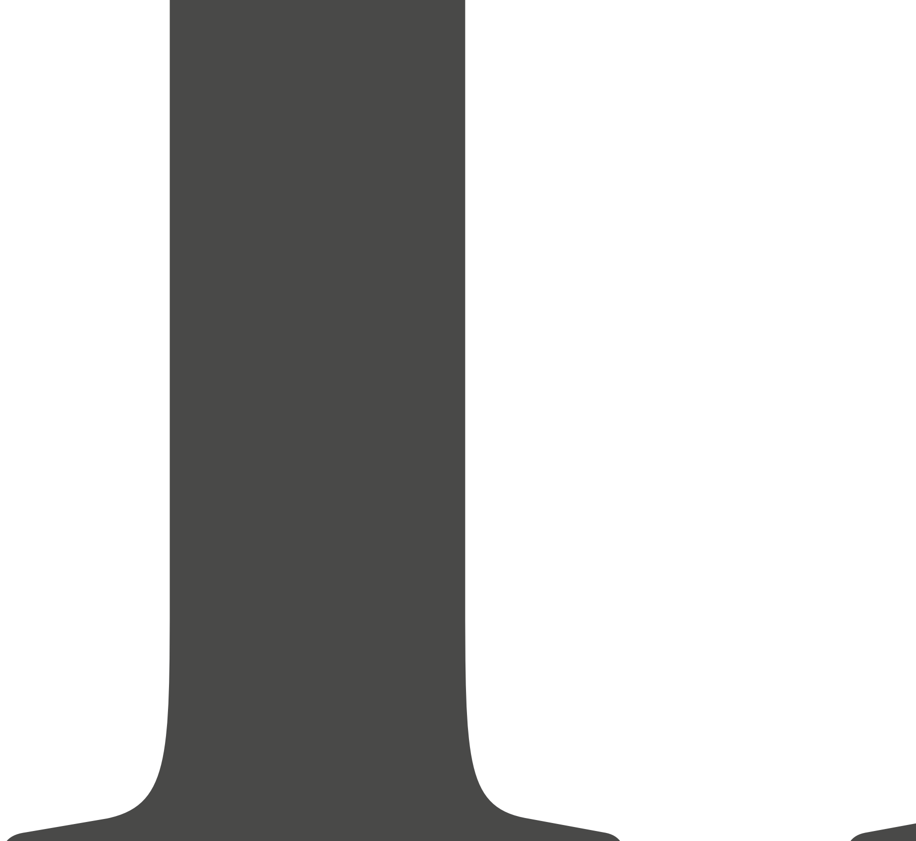


V

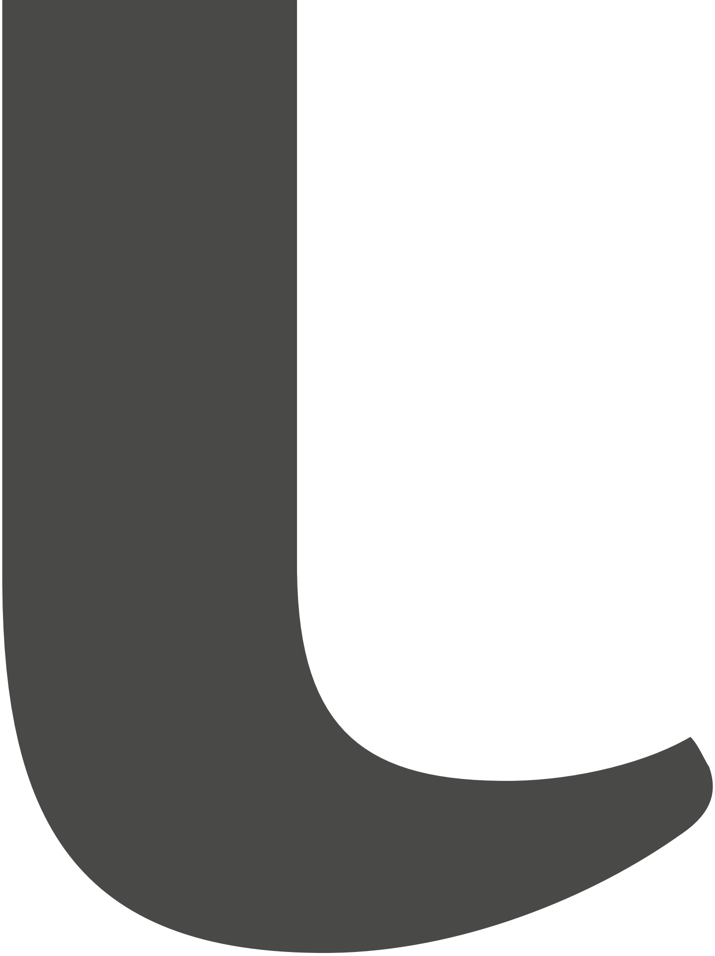
a

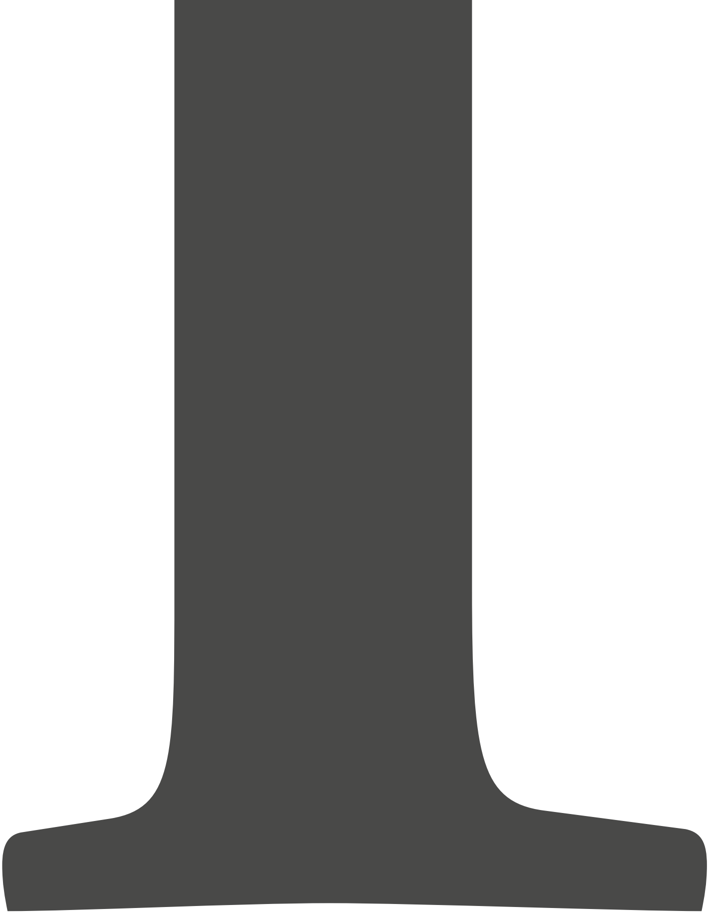


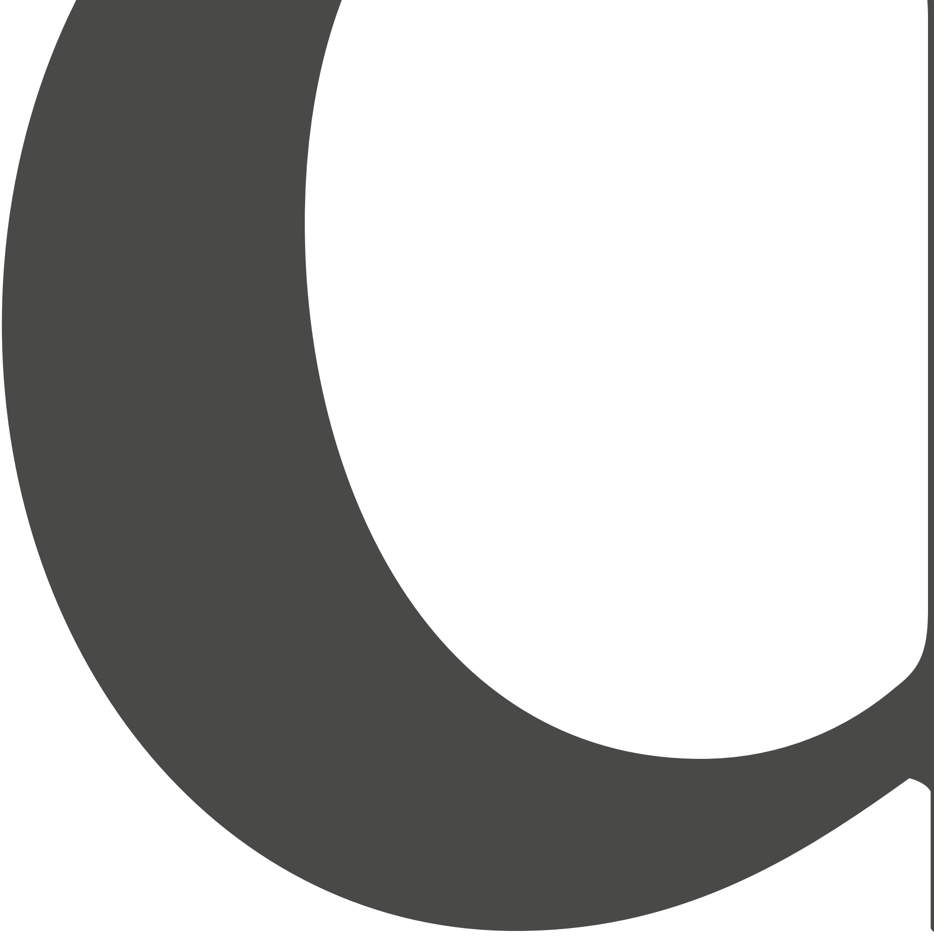


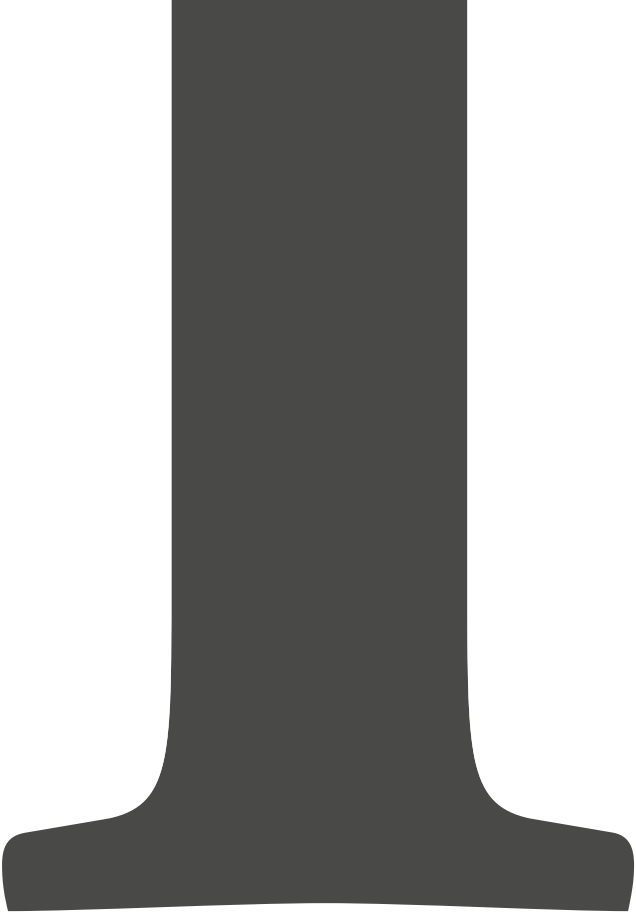


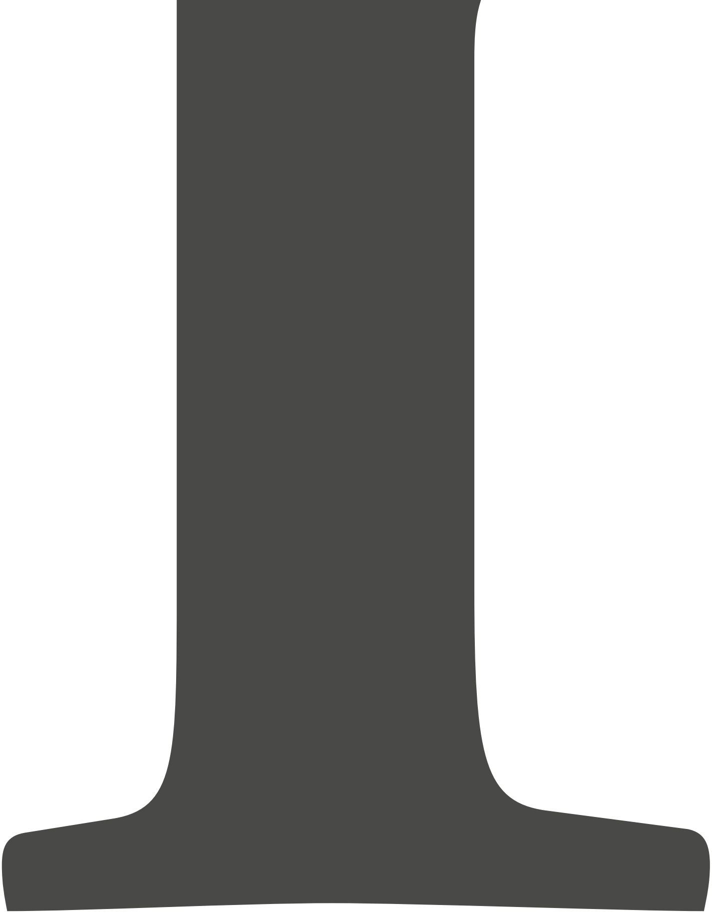
S











S

!

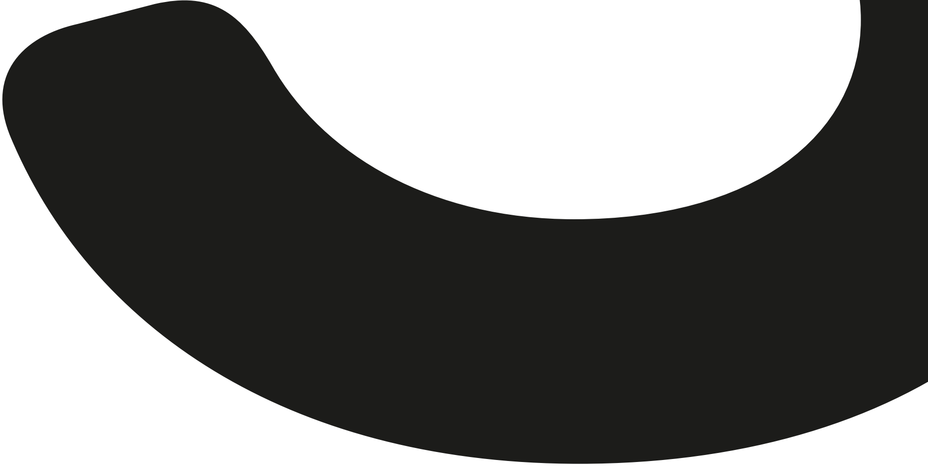
Ancient plants

F

sp

a

f



M

th

a

th

m

T

W

m

d

n

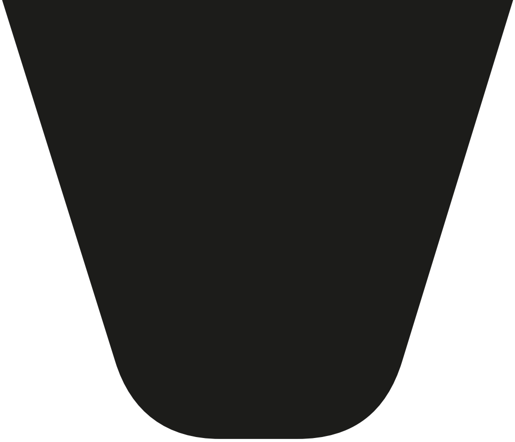
F

h

fr

m

sp



U

C

g

ro

th

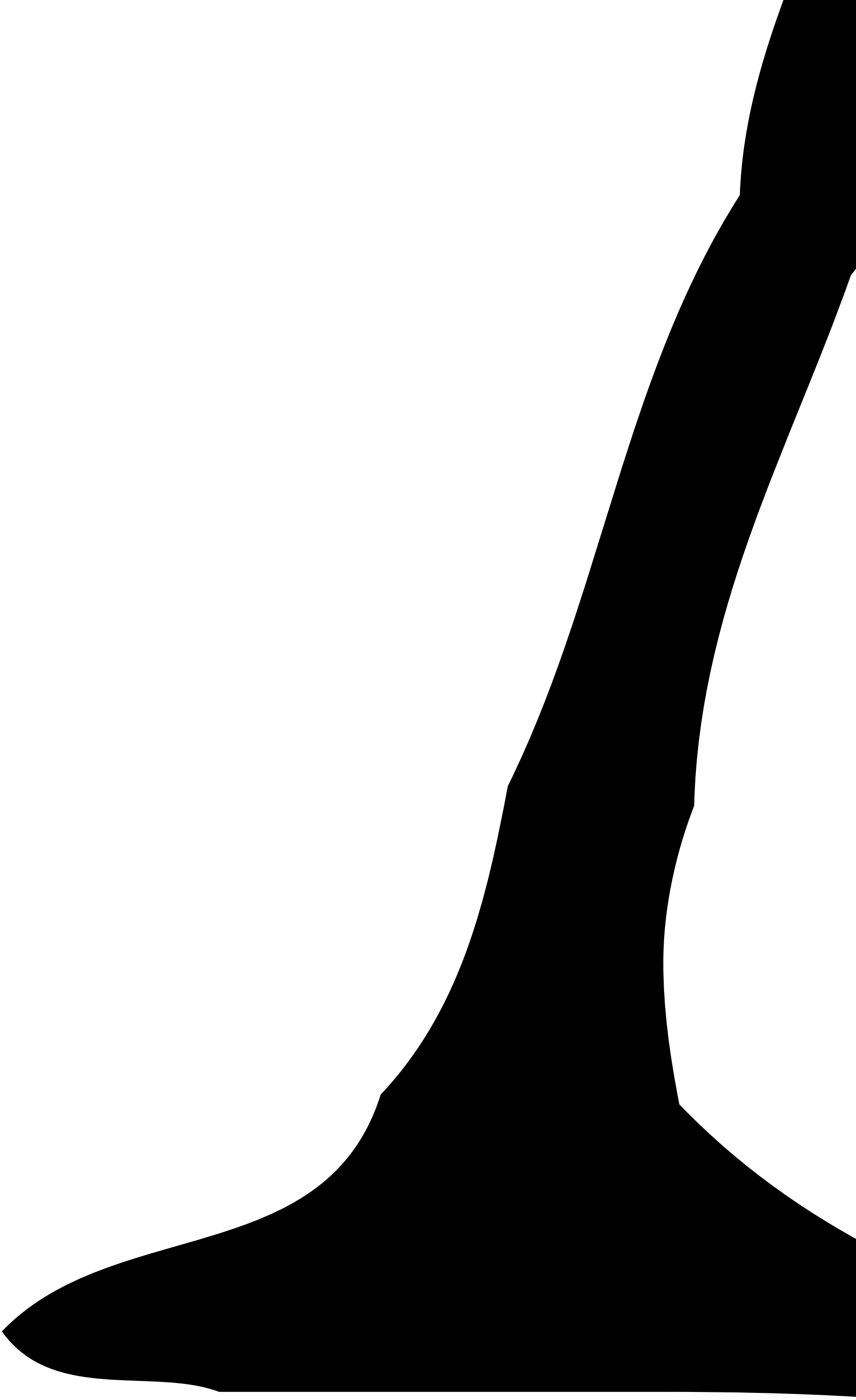
T

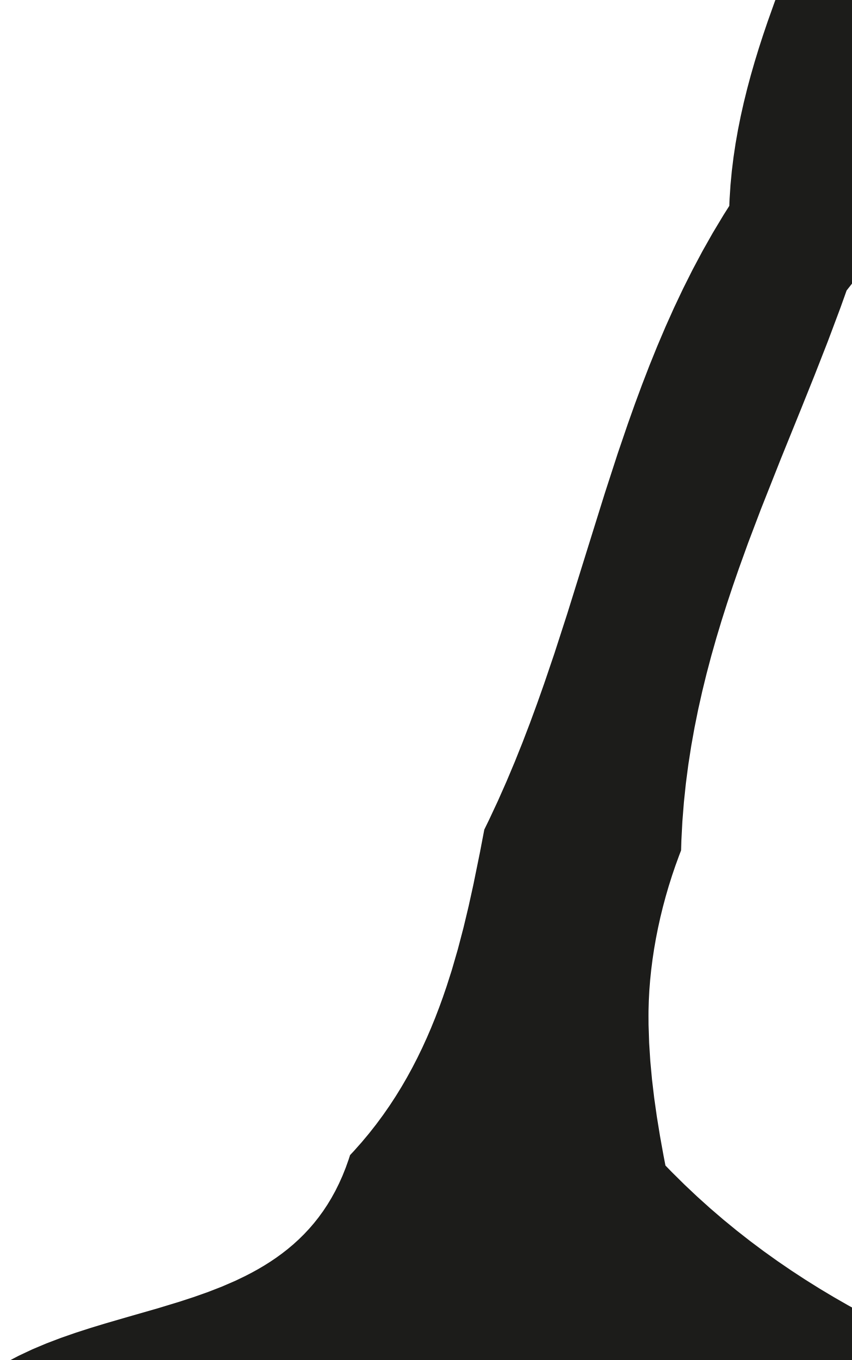
C

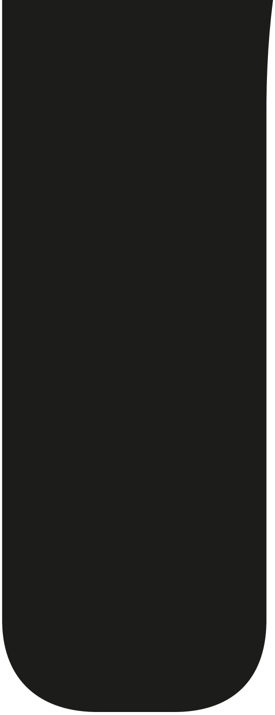
lt

u

19







Two kinds of plants

The most ancient plants alive are small and simple, such as mosses and liverworts. They are called nonvascular plants. The rest, including ferns and flowering plants, are known as vascular plants because they have veins to transport water, food, and minerals—like blood flowing through our bodies.

[redacted]

[redacted]

[redacted]

[redacted]

C

C

t

a

re

s

m

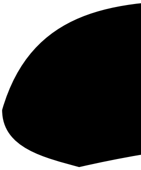
Li

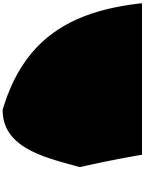
p

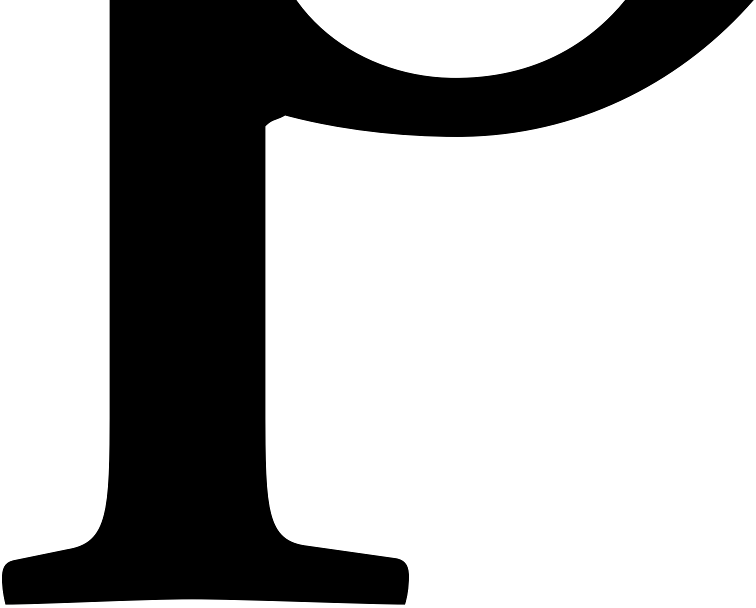
S

st

W







T

C

le

lik

T

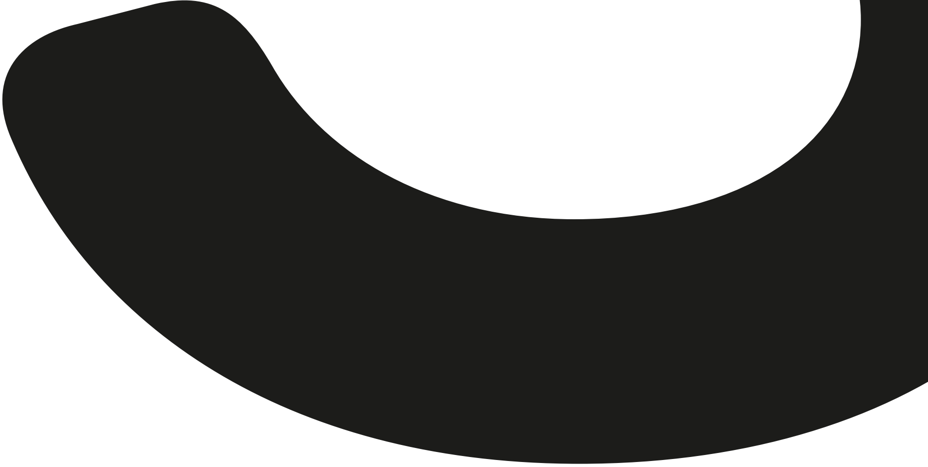
st

fo

N

m

V



T

sp

g

a

C

d

C

p

A

C

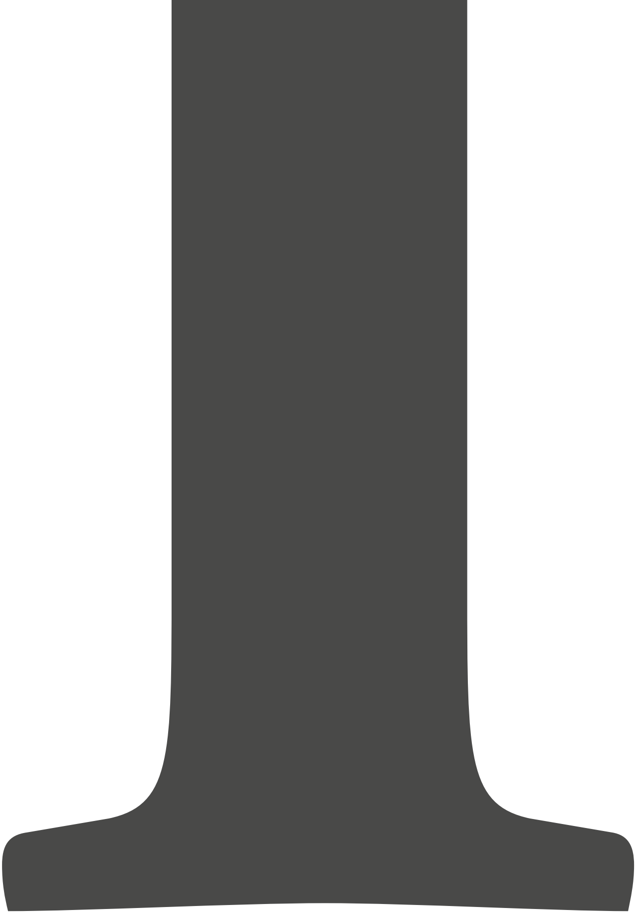
m

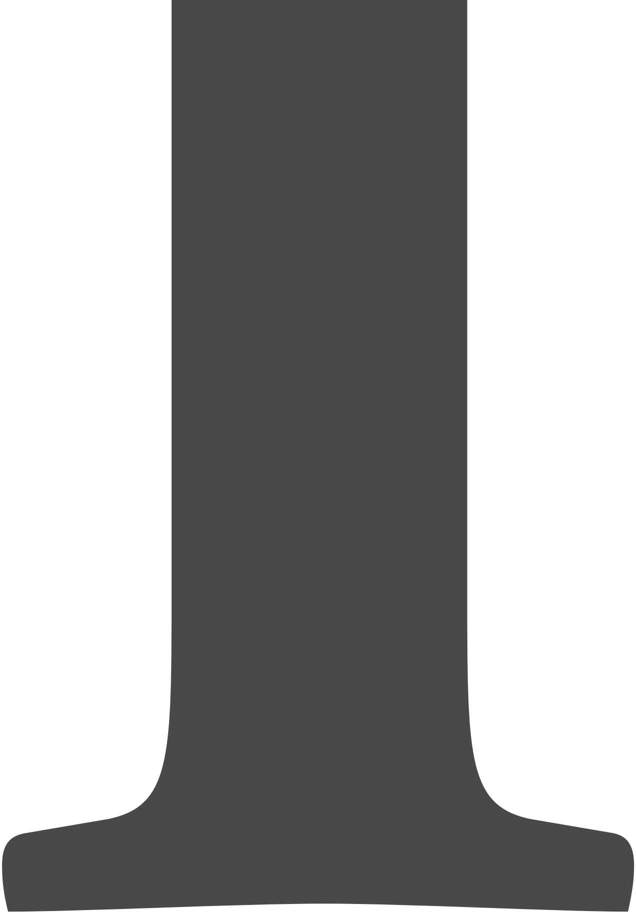
S

g

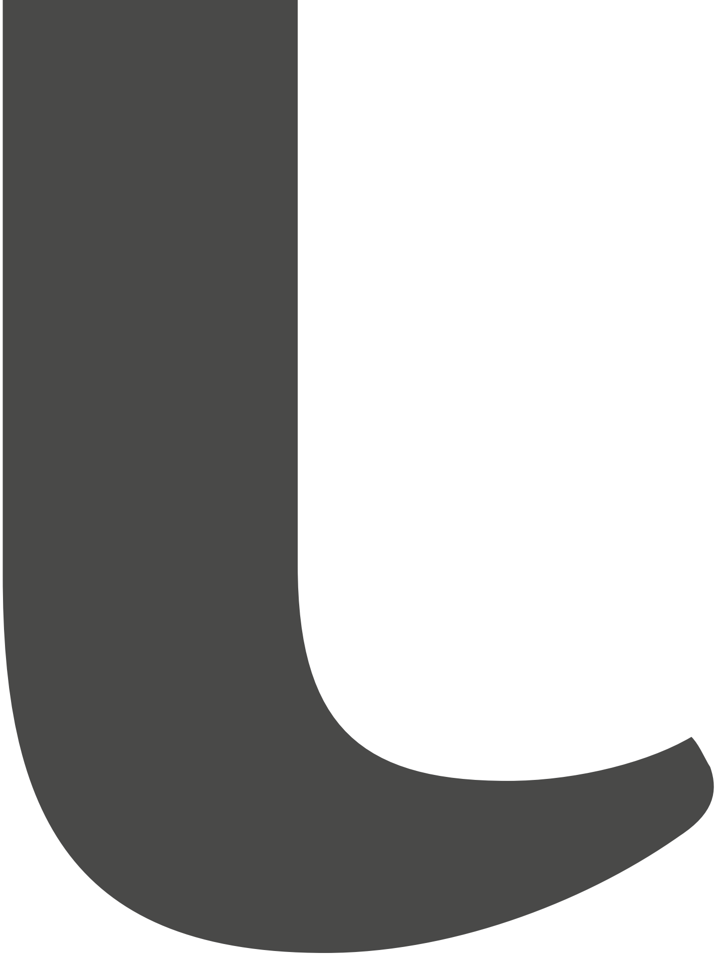
lo

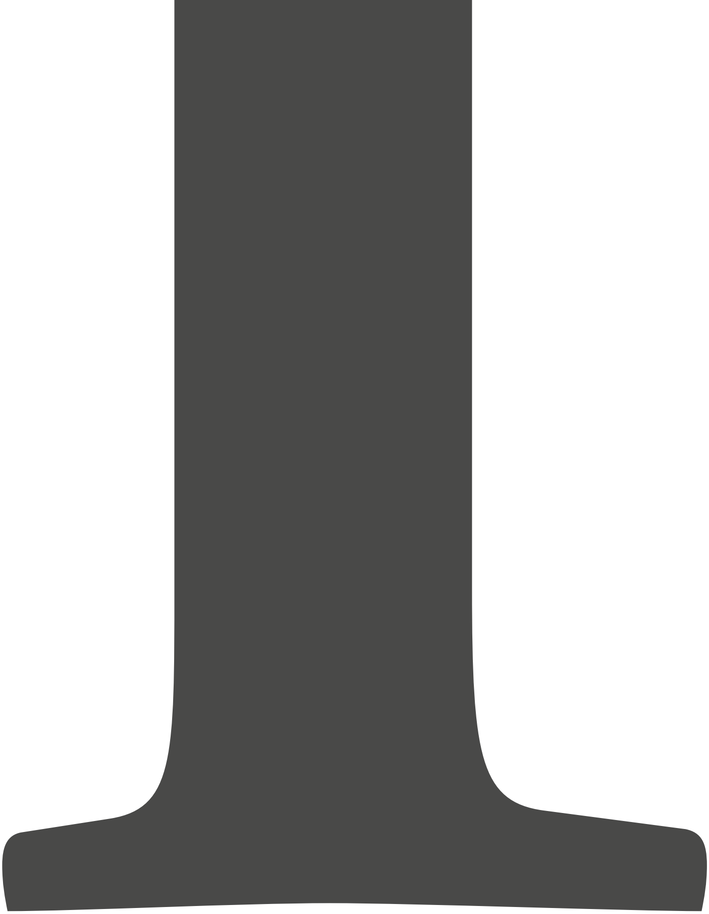
g





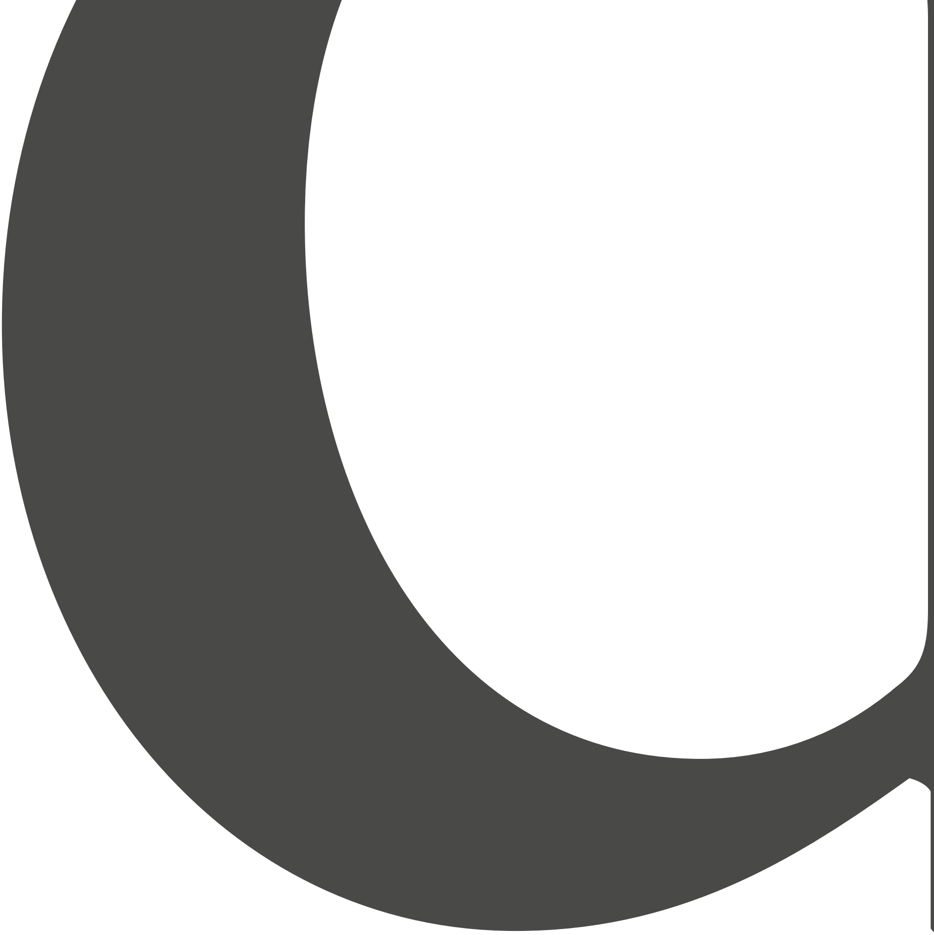
1

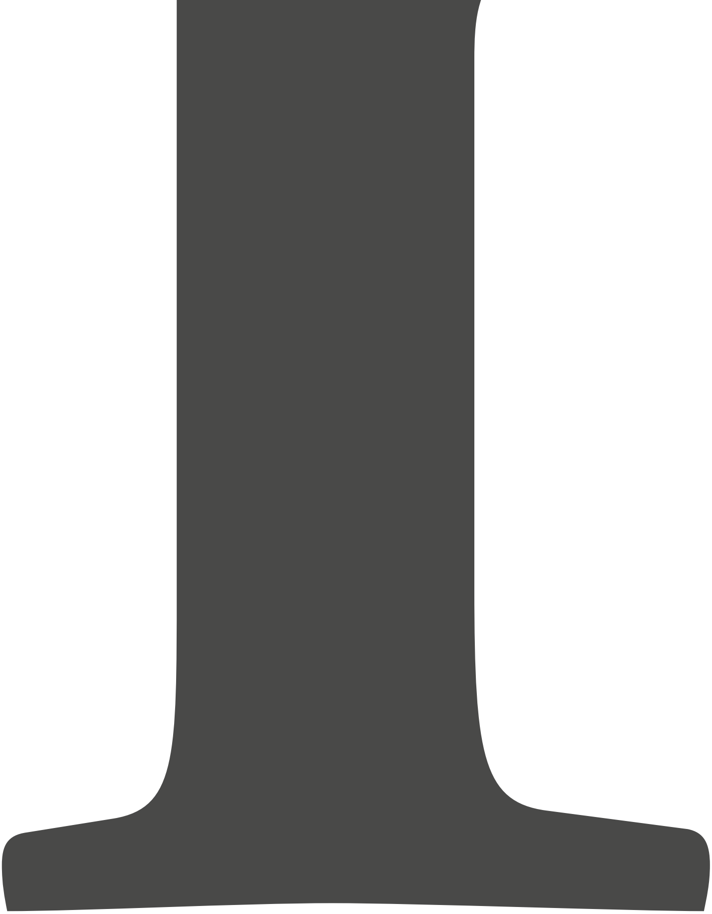


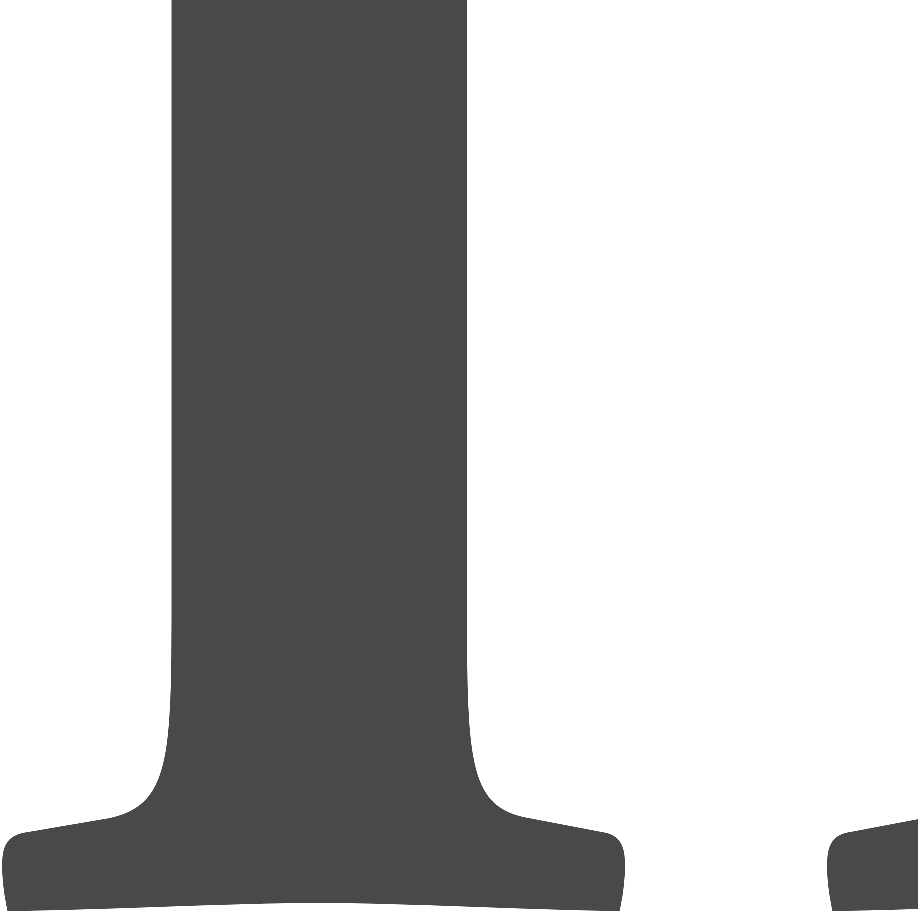


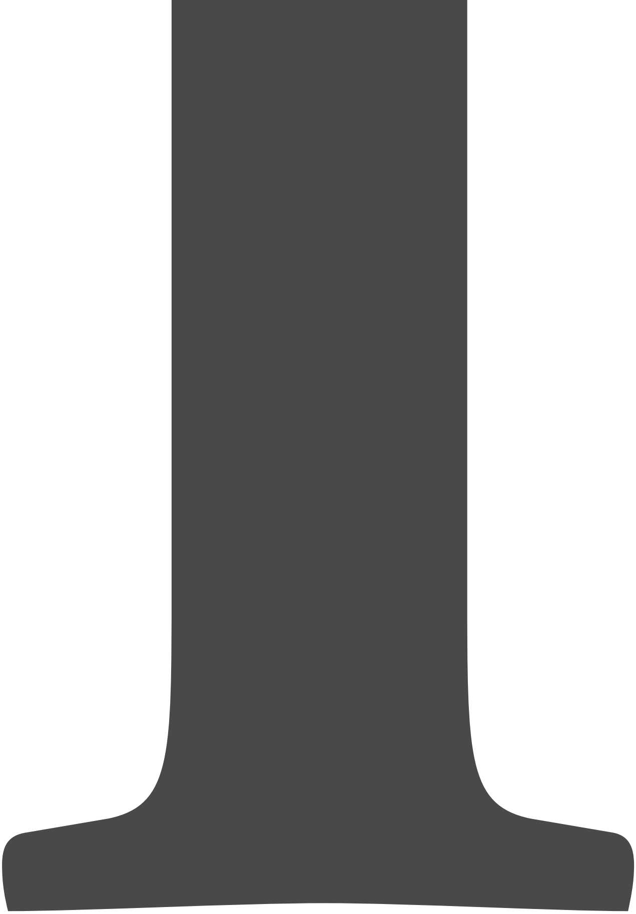
y

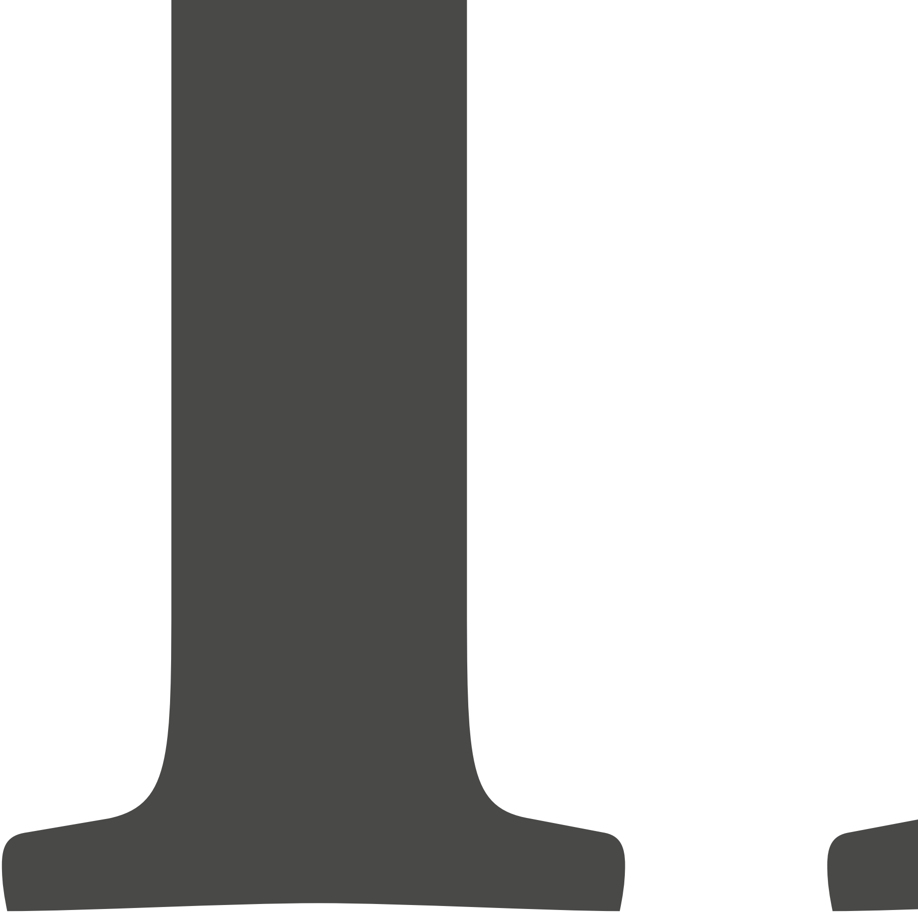
a

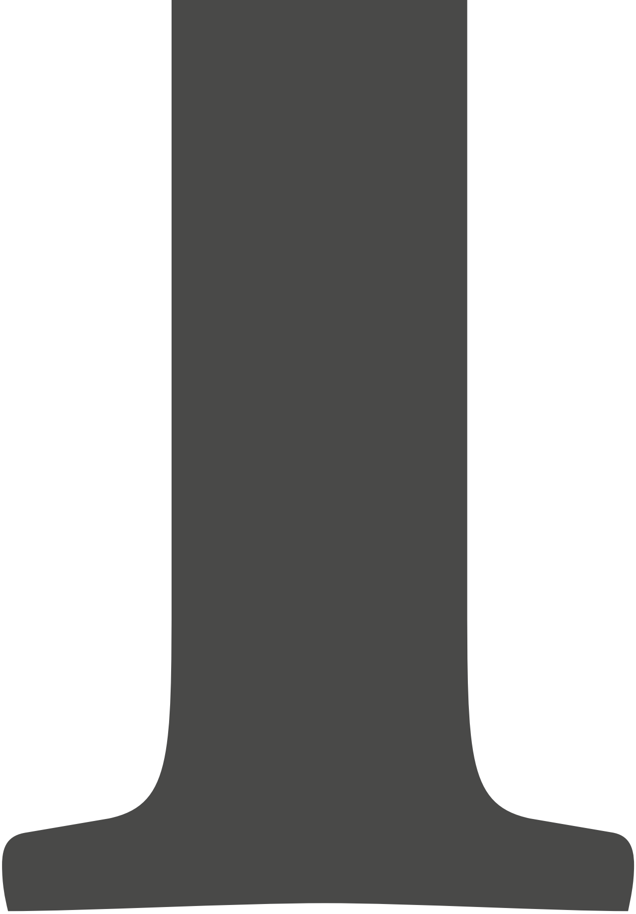




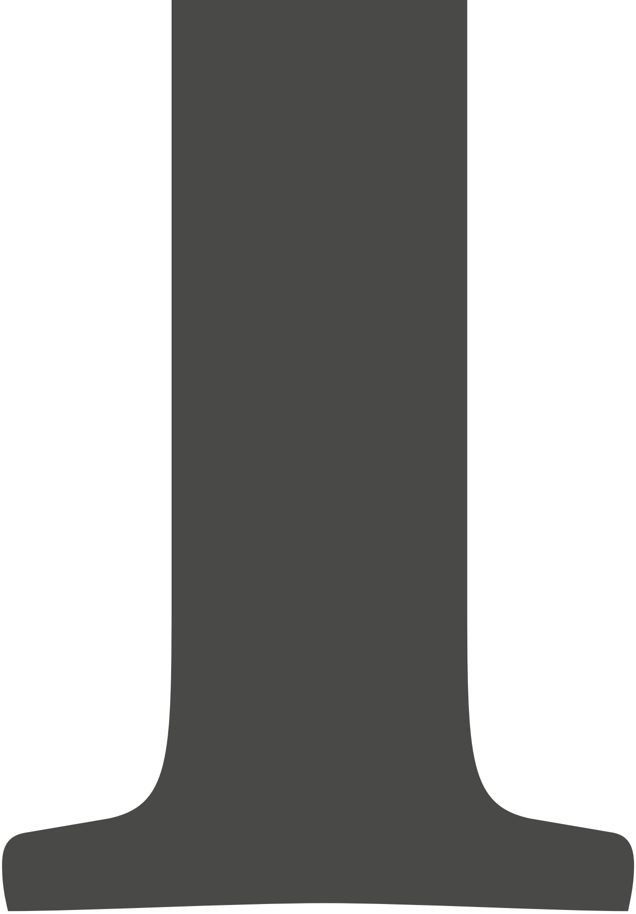


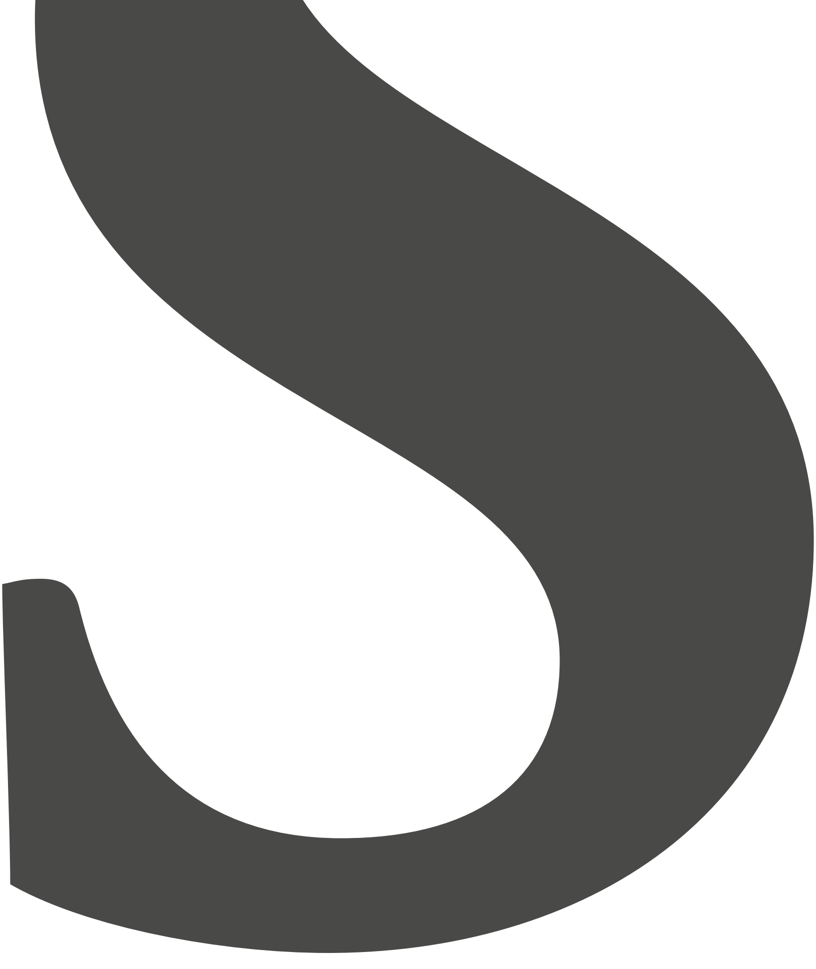


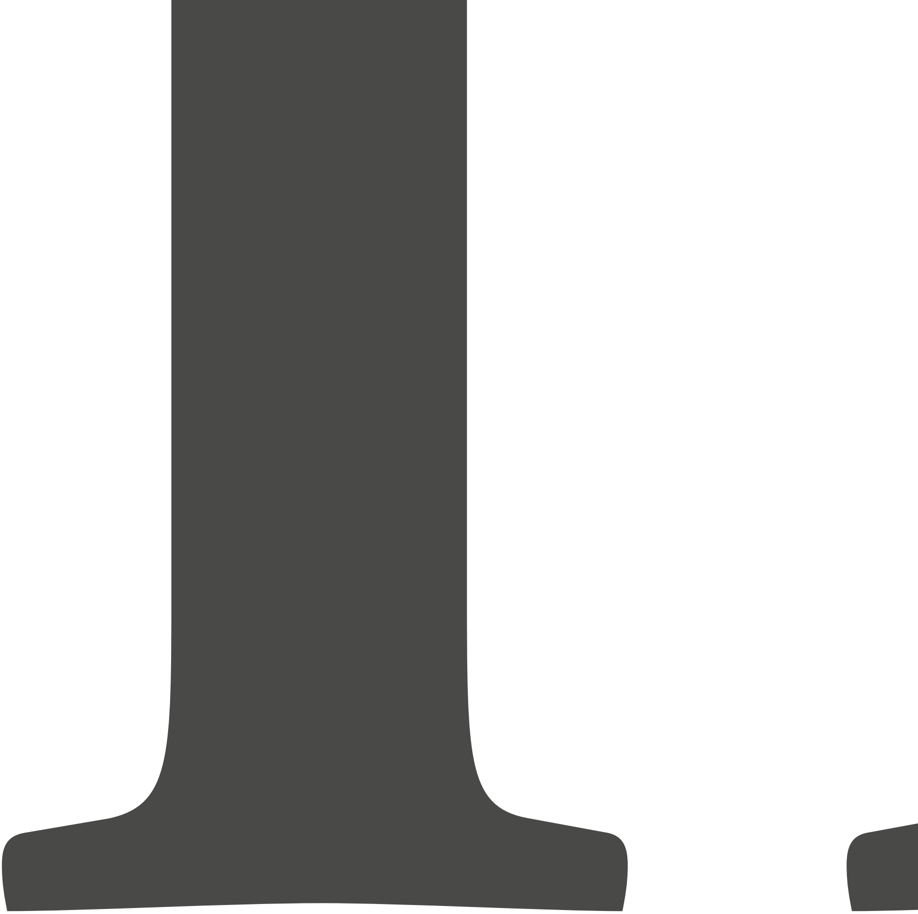


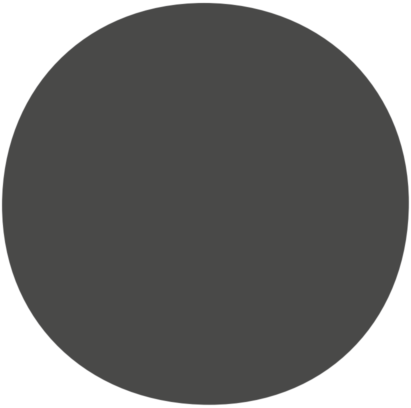


y

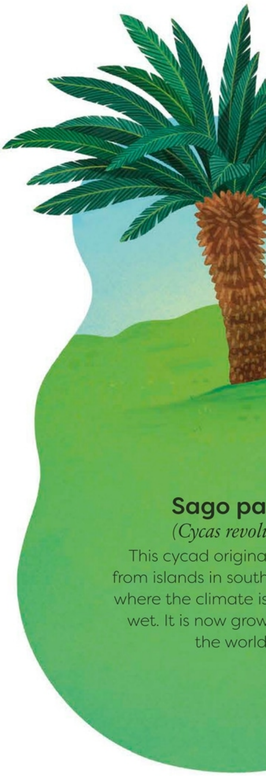








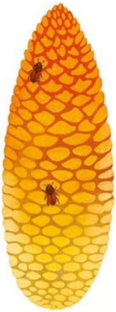
Cycad

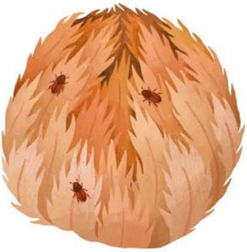


Sago pa

(Cycas revolu

This cycad origina
from islands in south
where the climate is
wet. It is now grow
the world





Beetle pollinators

Male cycads produce a single hard
cone that contains pollen. Pollen-e
beetles are attracted to it. If the be
then visit a female cycad, some of
sticky pollen rubs off onto the huge
female cone. The fertilized cone no
develops seeds.

[redacted]

M

C

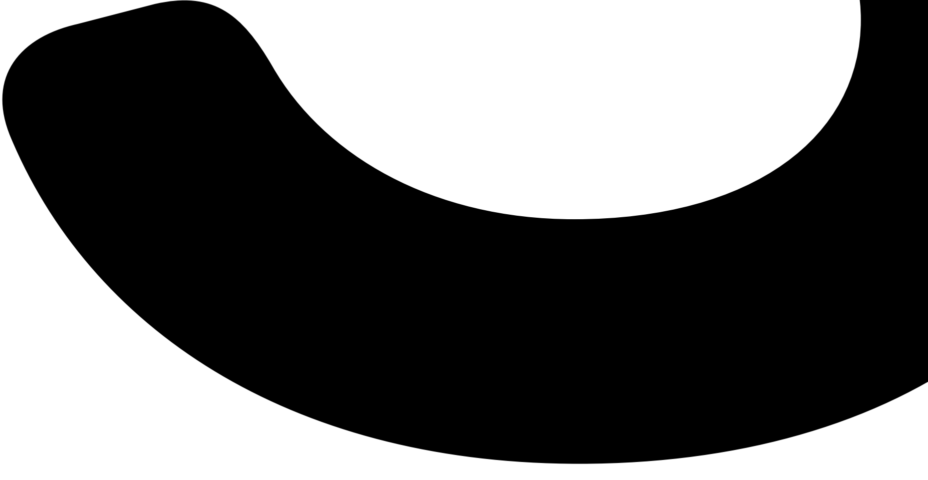
b

th

st

fe

d



T

fr

w

W

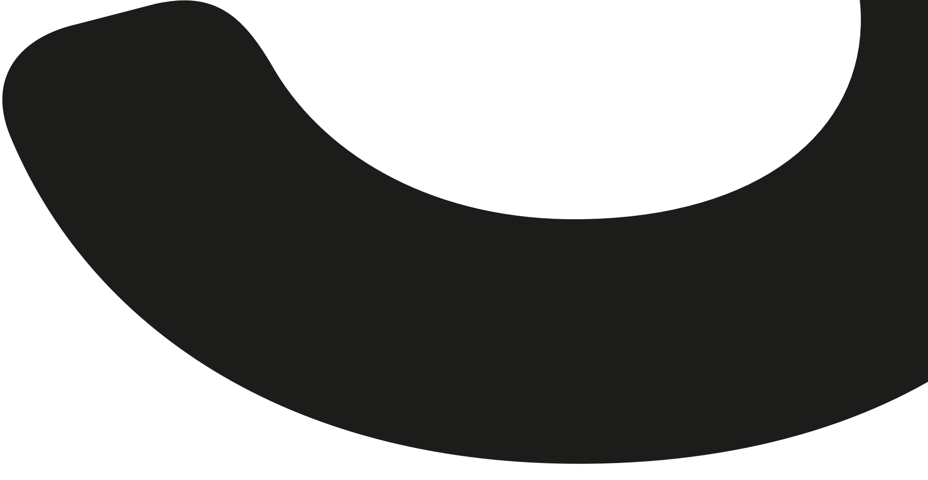
th

M

E

di

sr



U

th

ro

C

th

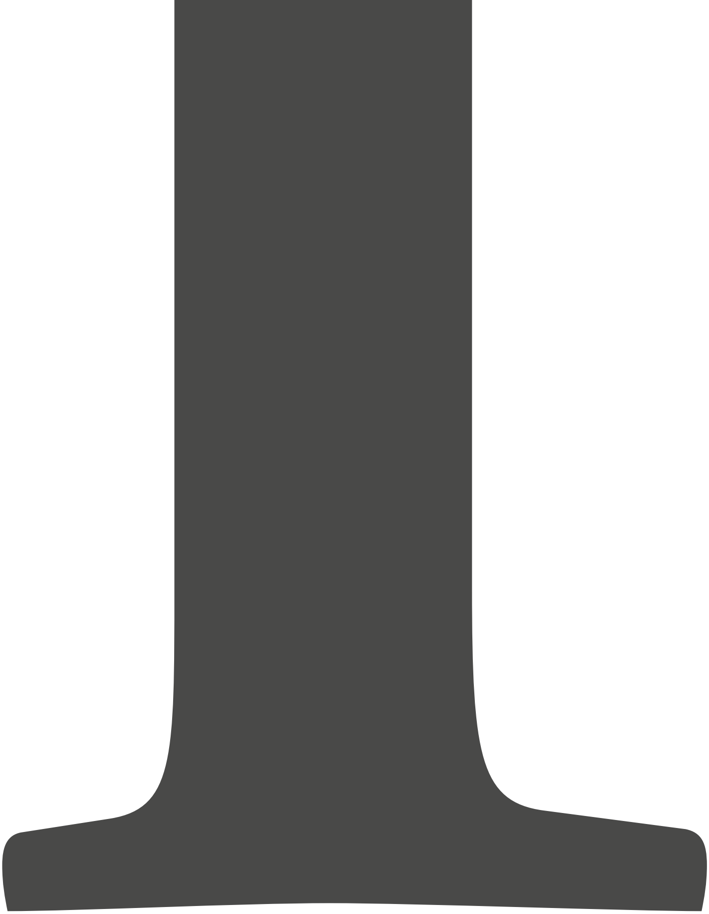
A

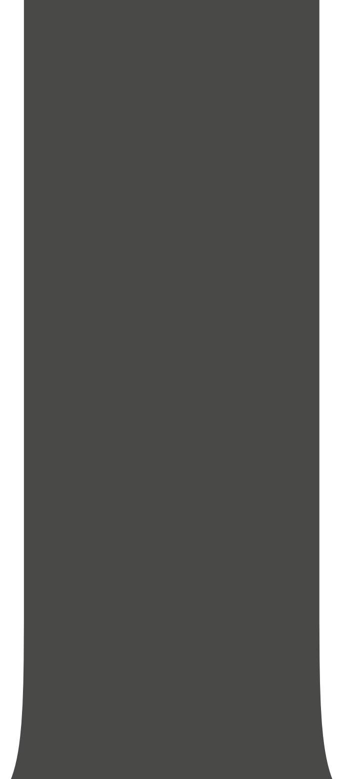
le

th

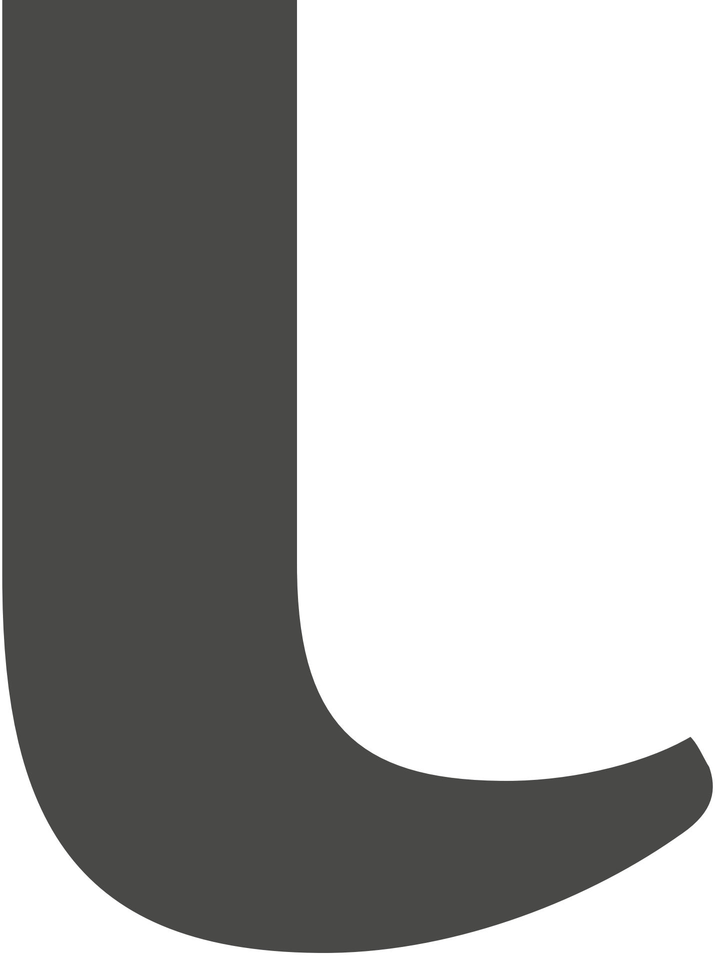
e

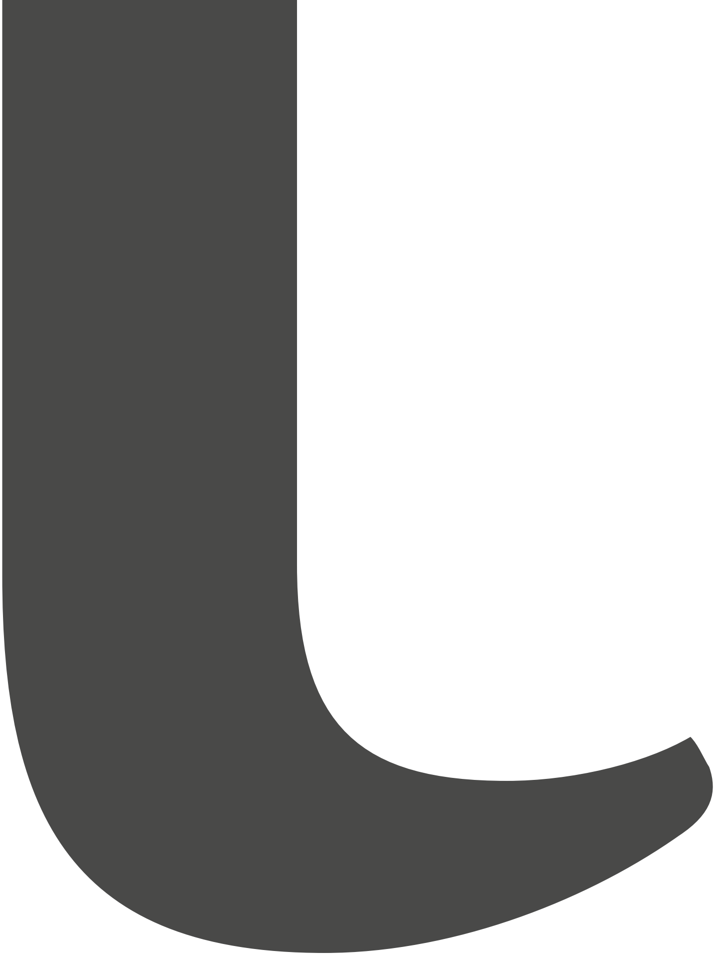
t

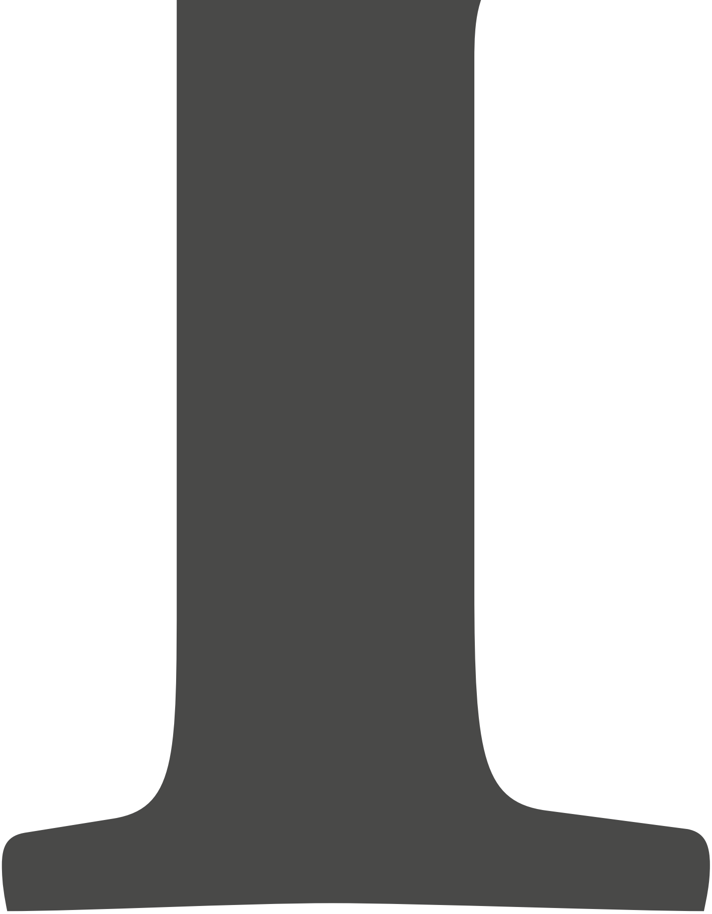


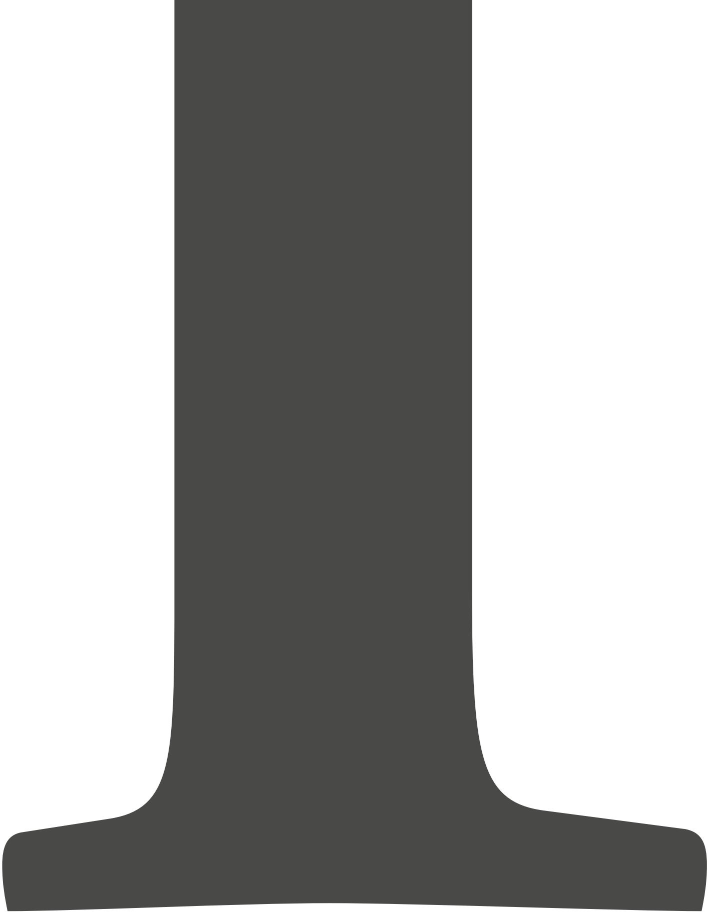


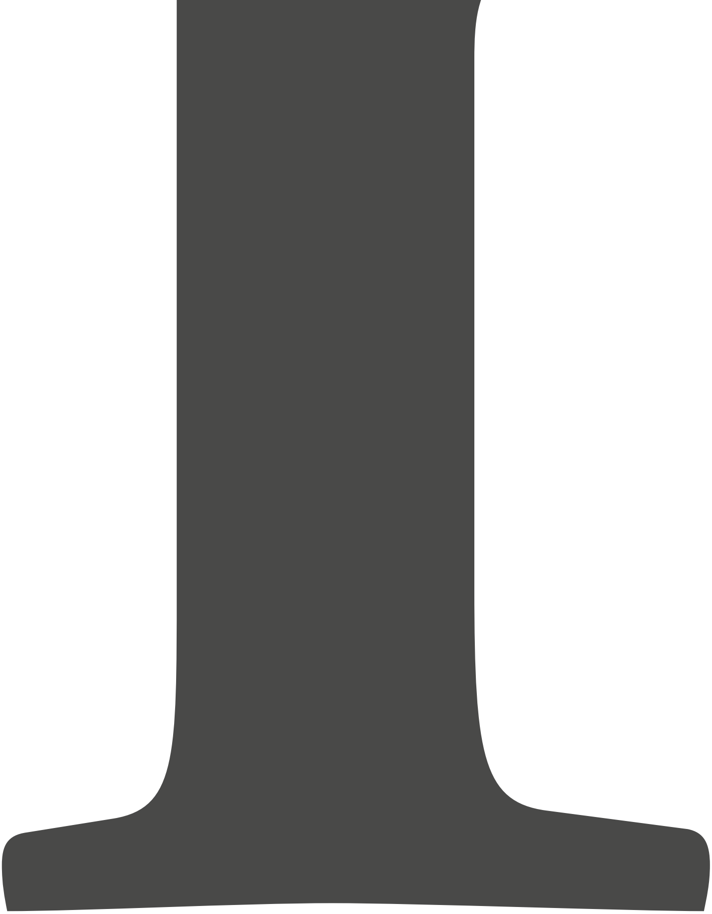
1

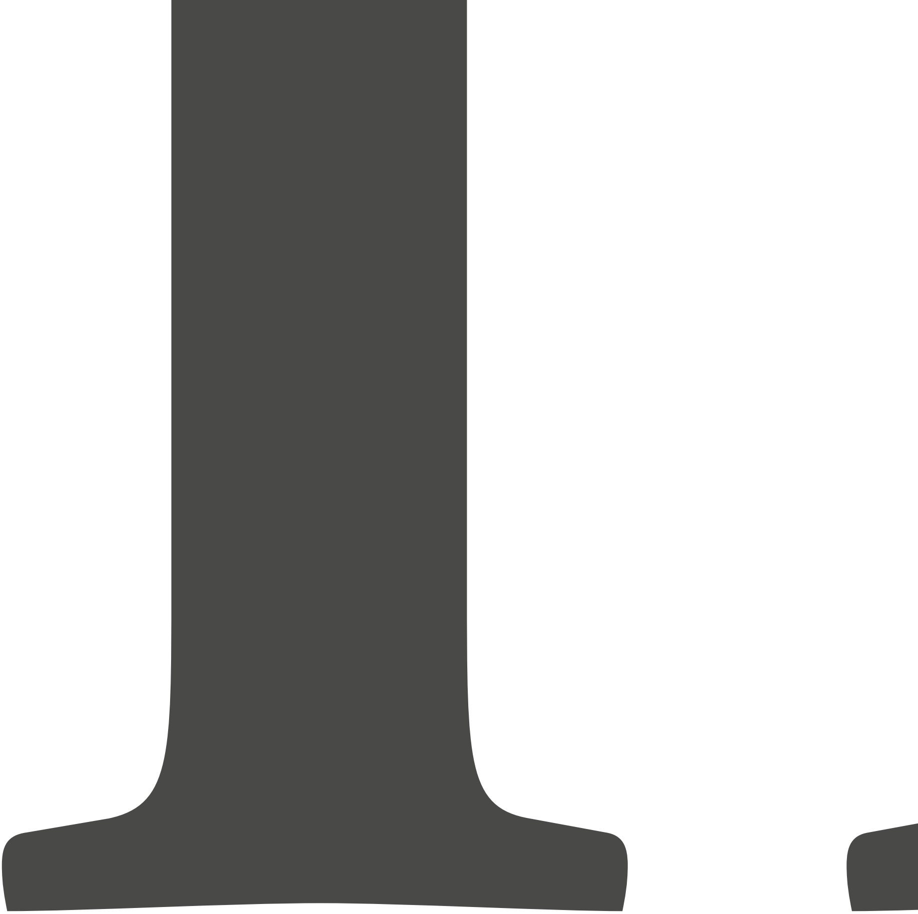


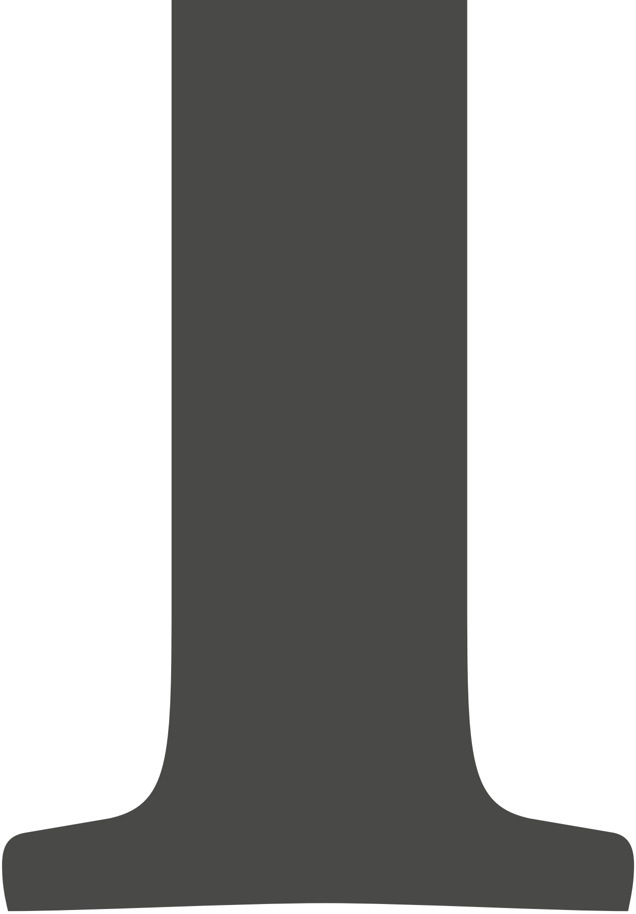


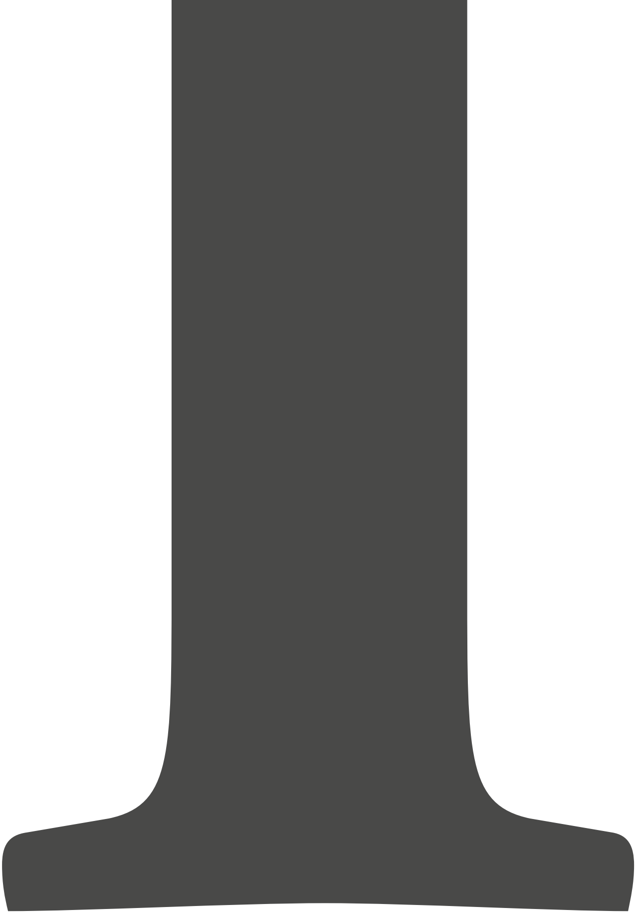




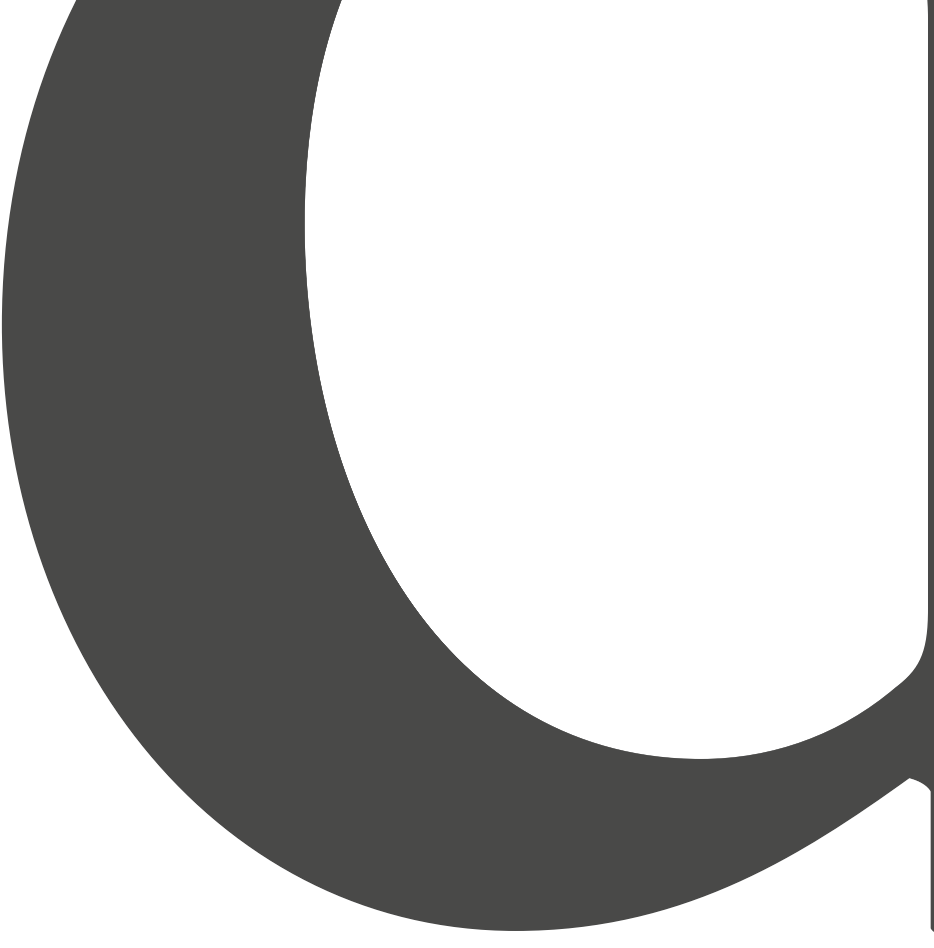


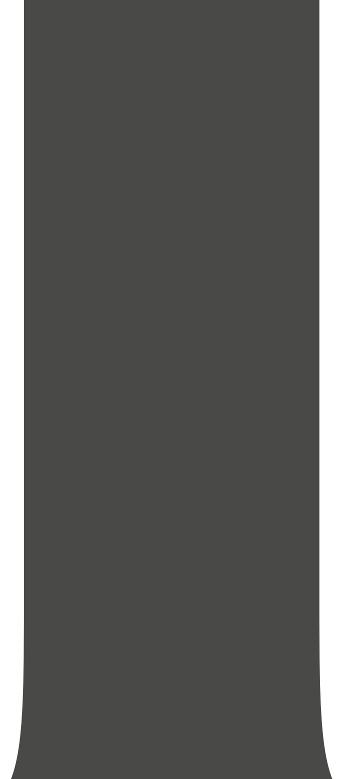


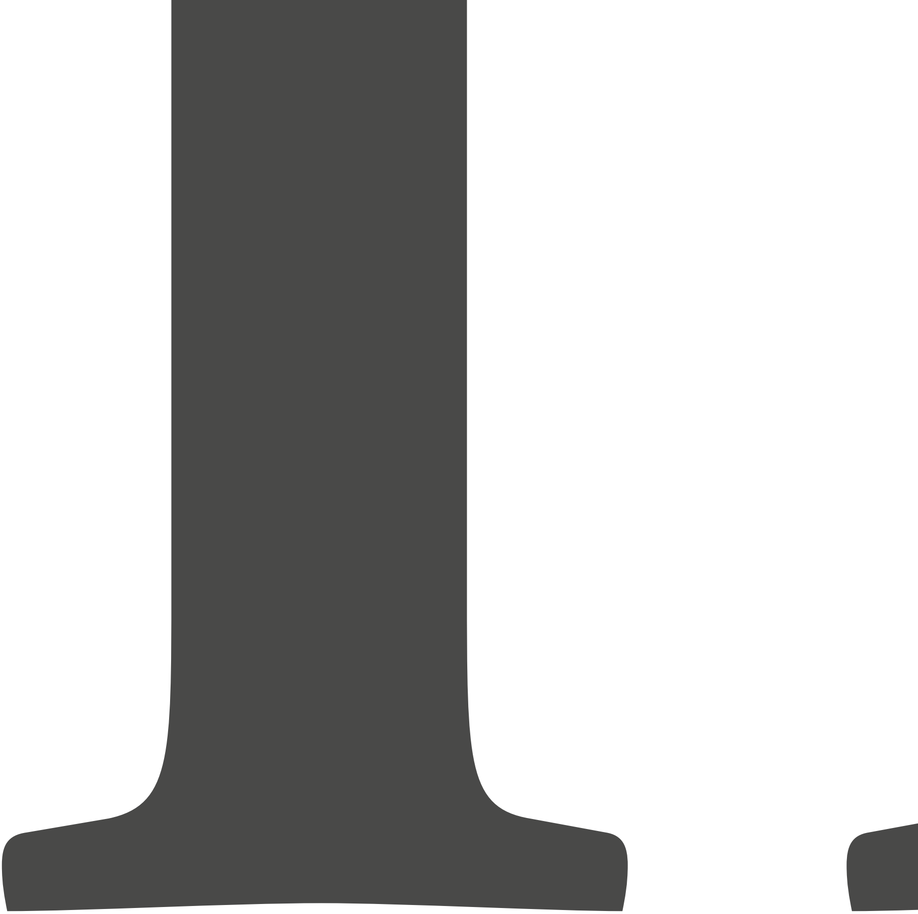


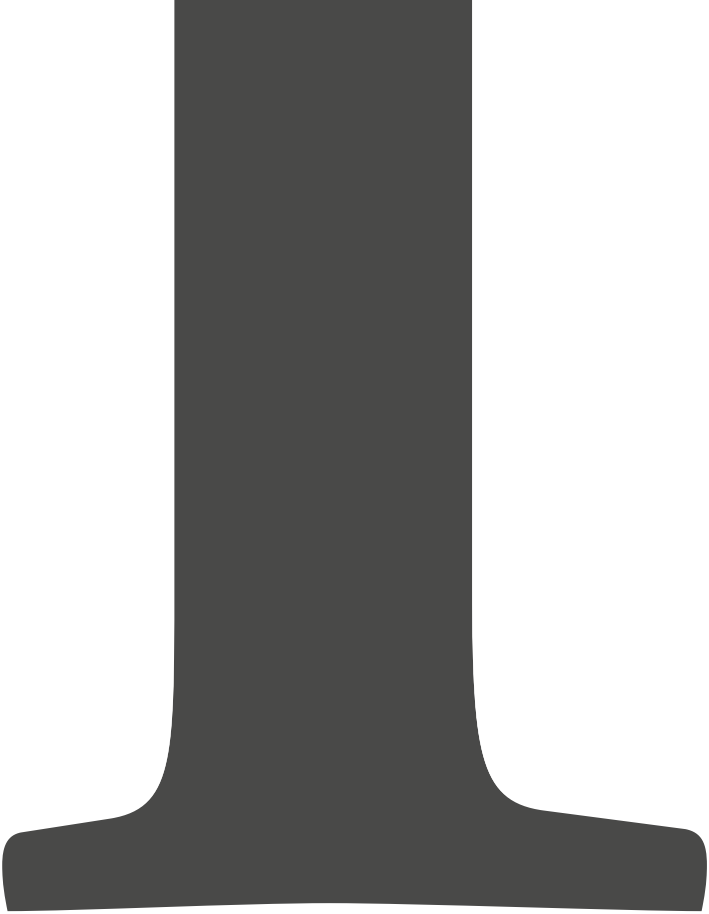


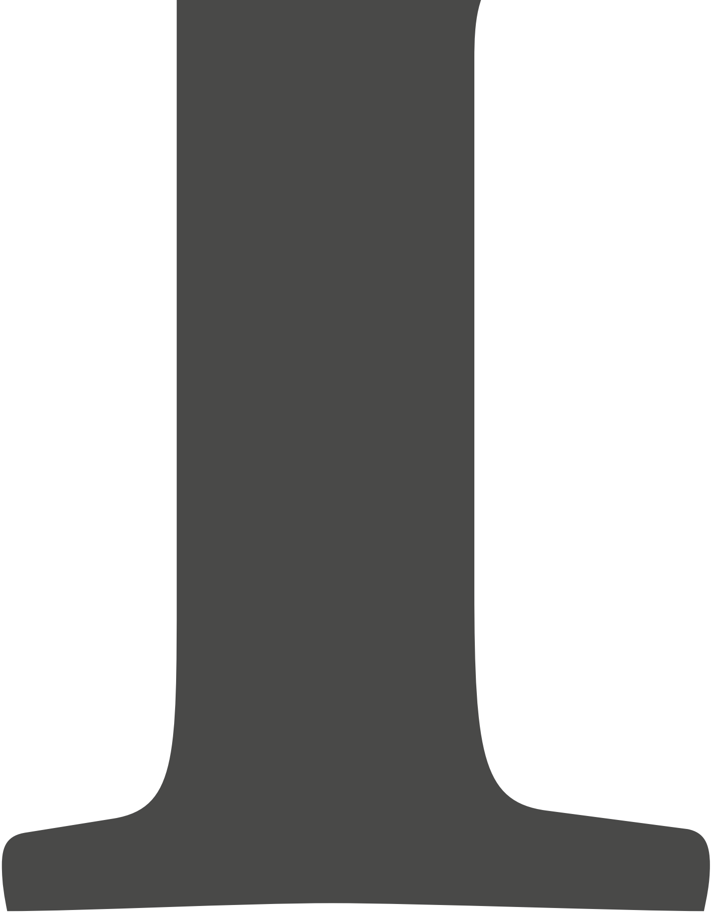
V

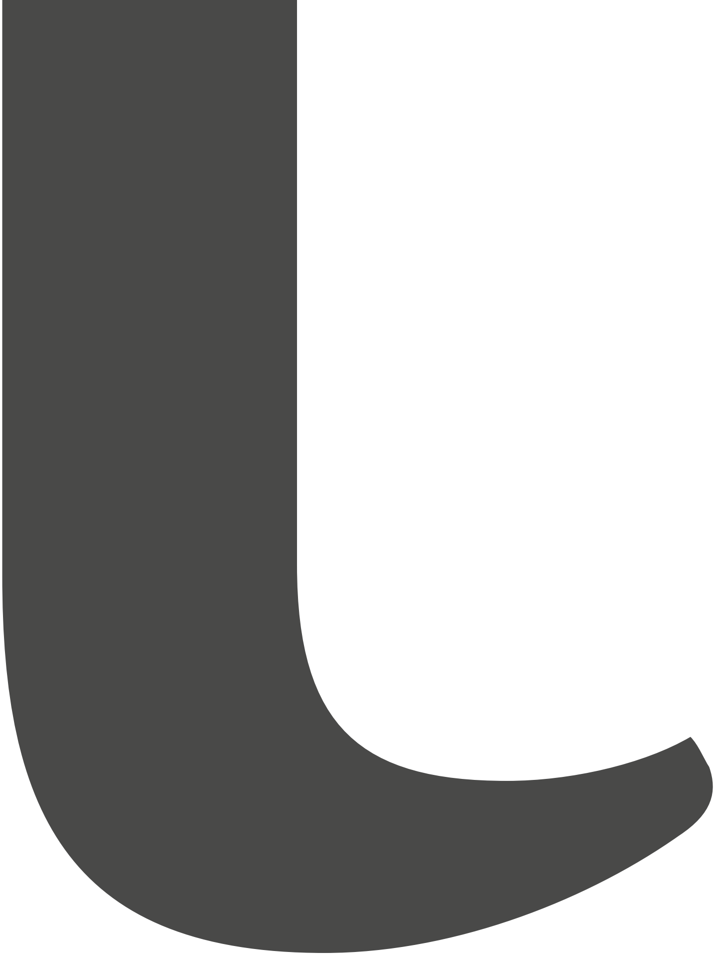


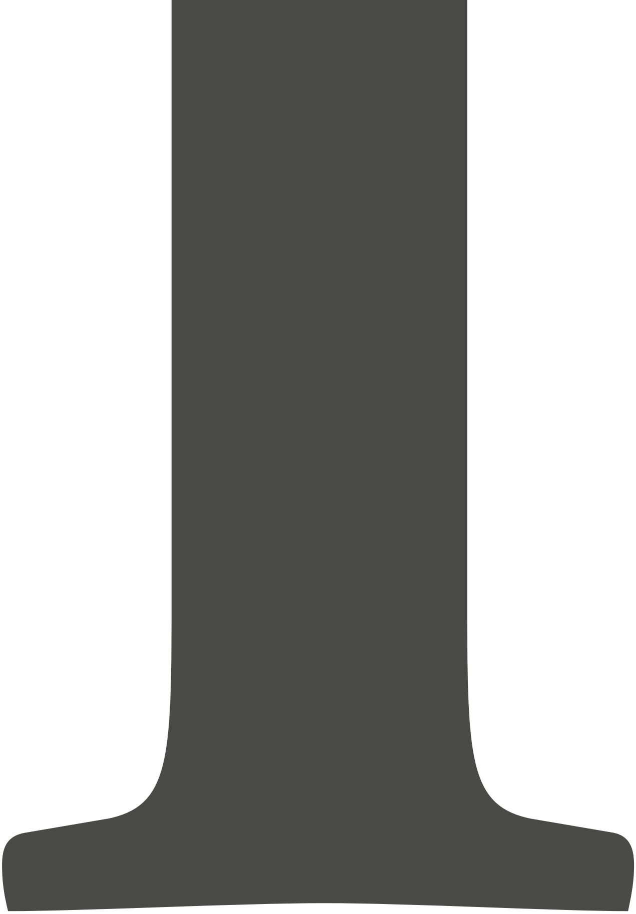


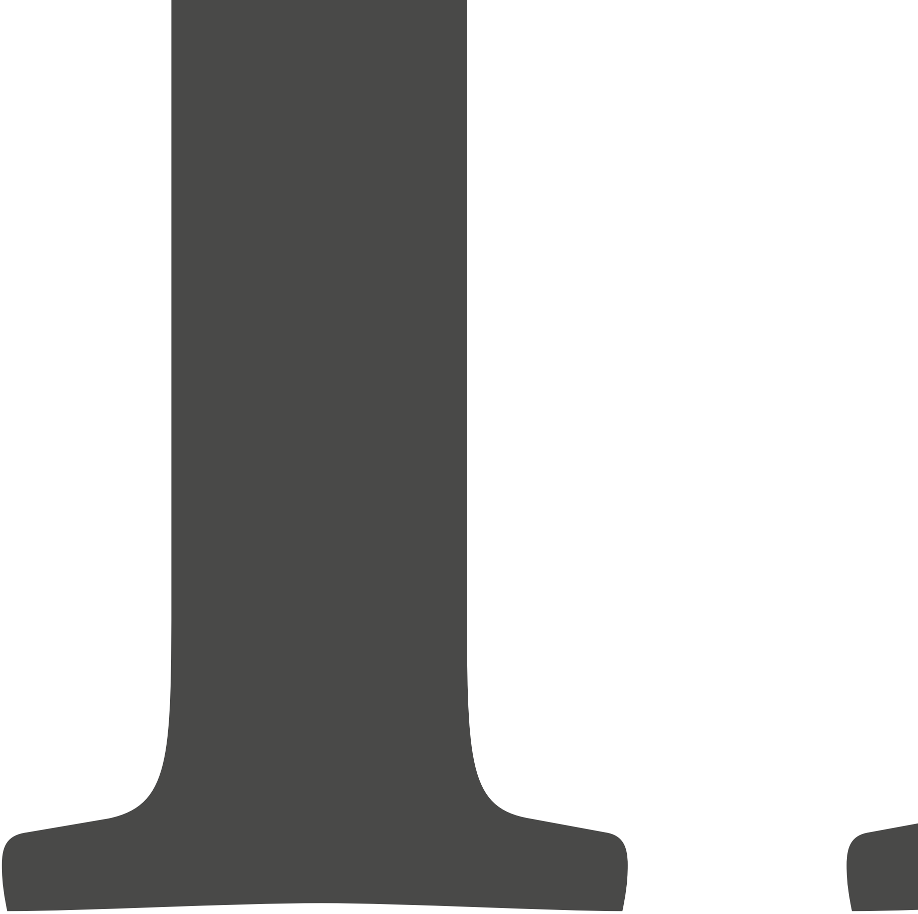






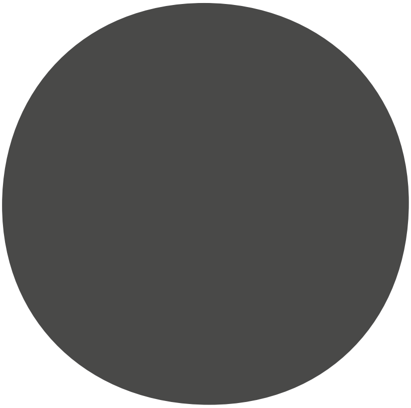




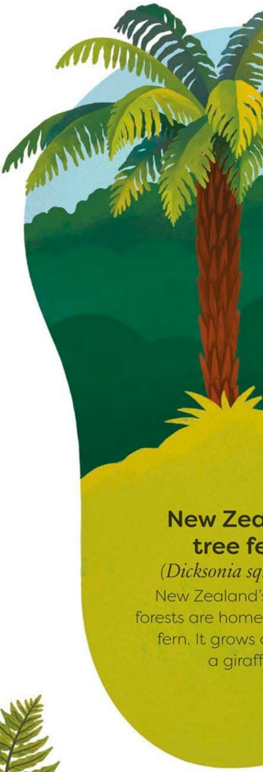


1

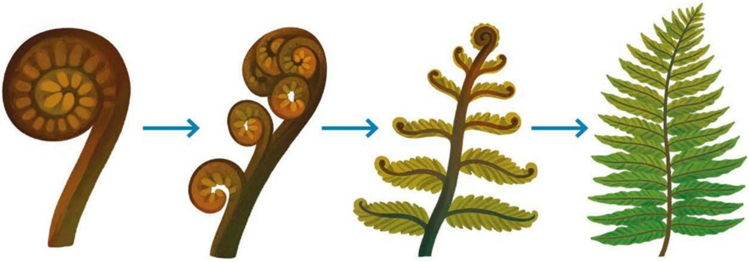
S



Tree fern



New Zea
tree fe
(Dicksonia sq
New Zealand's
forests are home
fern. It grows
a giraff



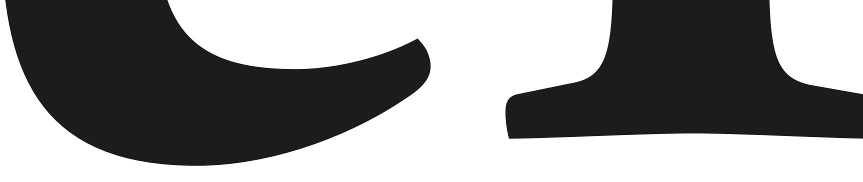
Birth of a frond

A new fern frond, called a fiddlehead, is curled up tight like a roll of paper. The frond uncurls while it pushes upward. As it continues to grow, many symmetrical leaflets extend on each side of the stem.

[redacted]

L

IN



A

lik

u

le

N

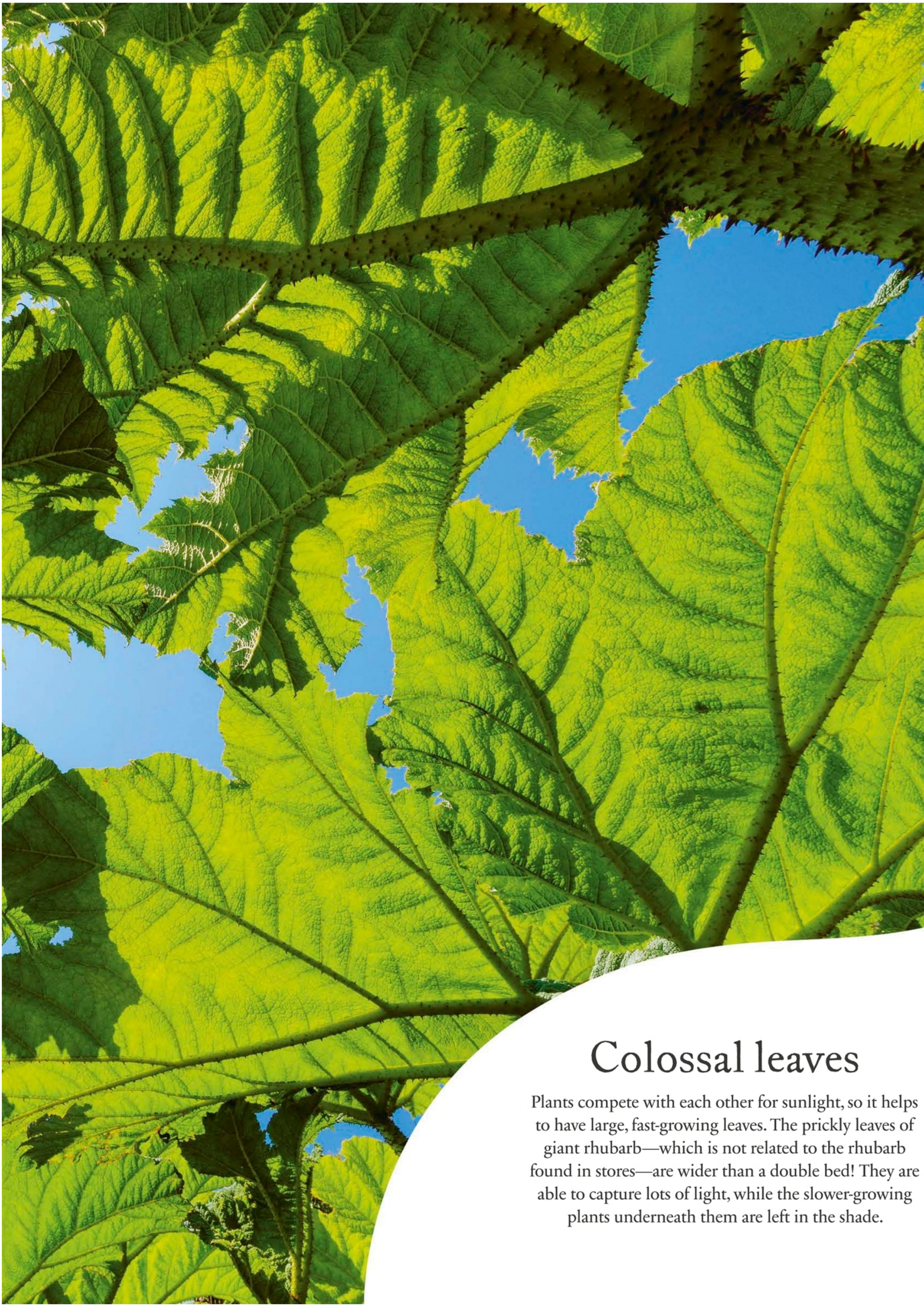
fo

fe

a

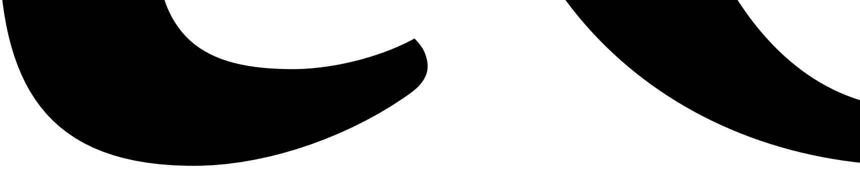
F

F

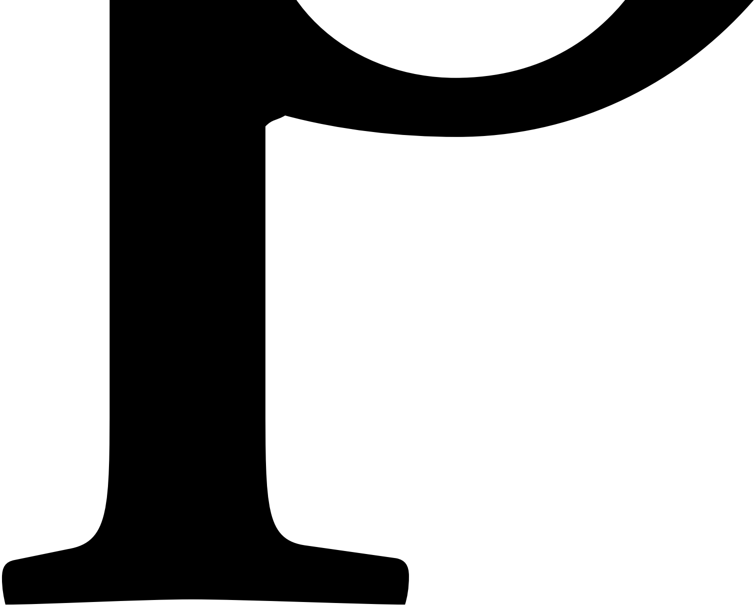


Colossal leaves

Plants compete with each other for sunlight, so it helps to have large, fast-growing leaves. The prickly leaves of giant rhubarb—which is not related to the rhubarb found in stores—are wider than a double bed! They are able to capture lots of light, while the slower-growing plants underneath them are left in the shade.



g



M

g

in

st

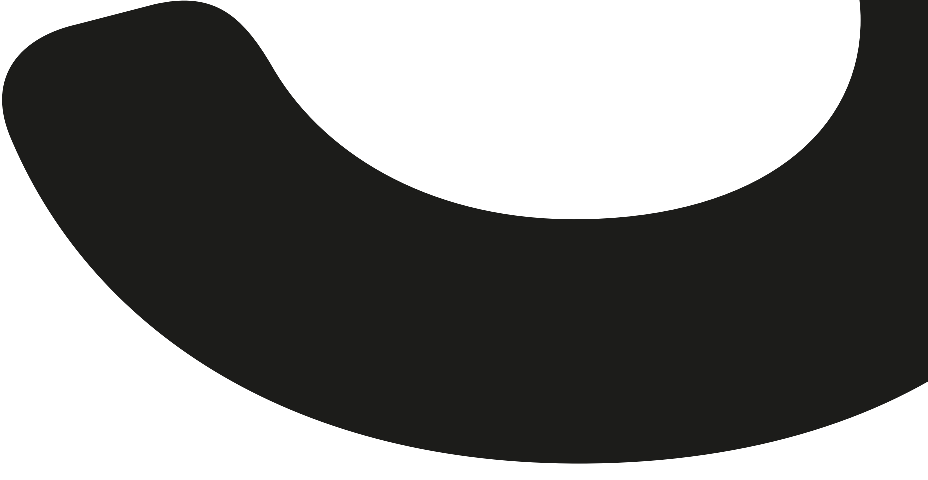
15

le

T

C

in



W

th

sp

T

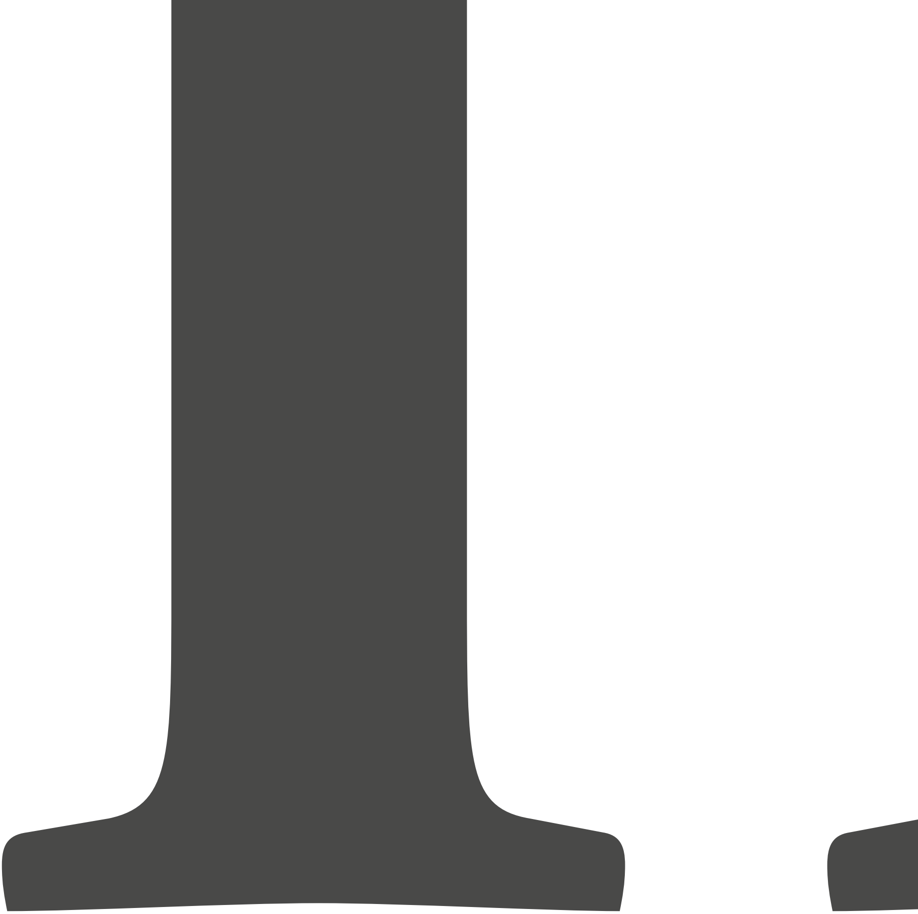
m

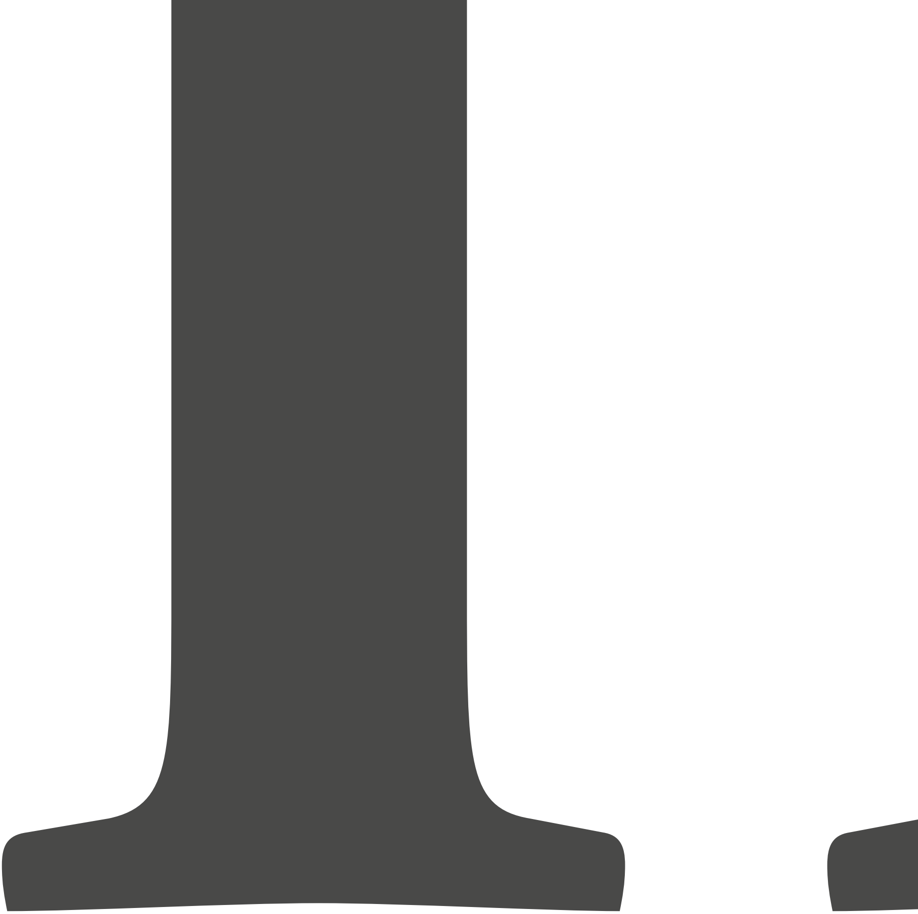
b

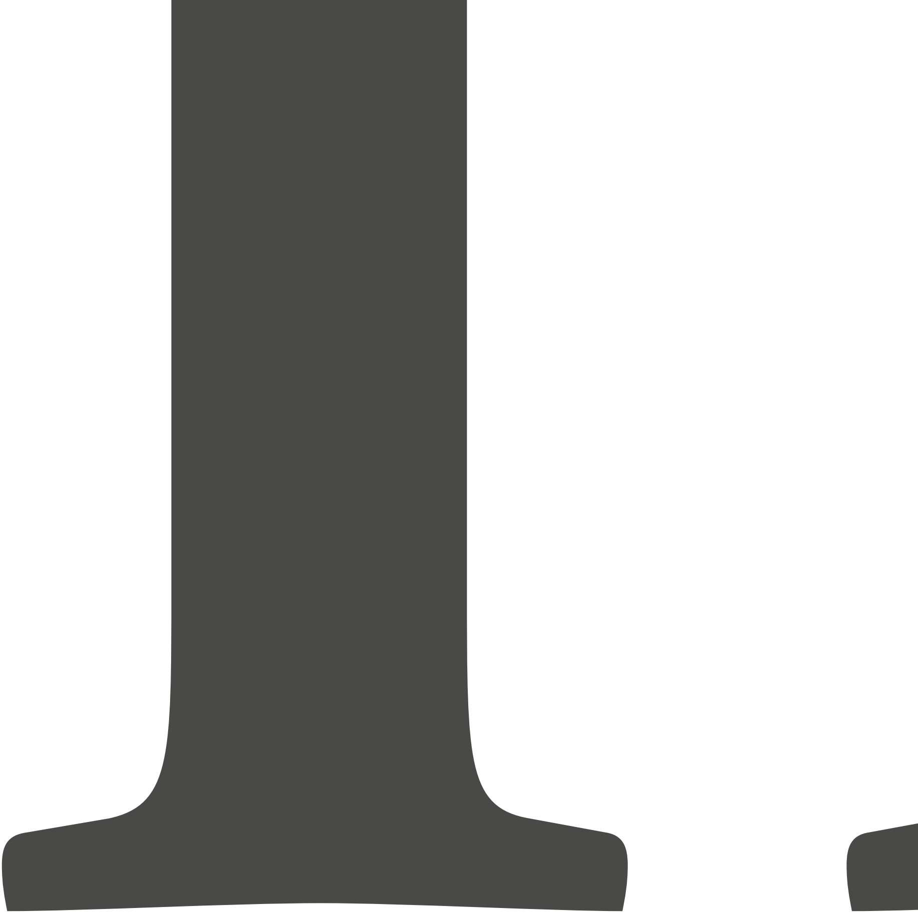
Th

g

Vi

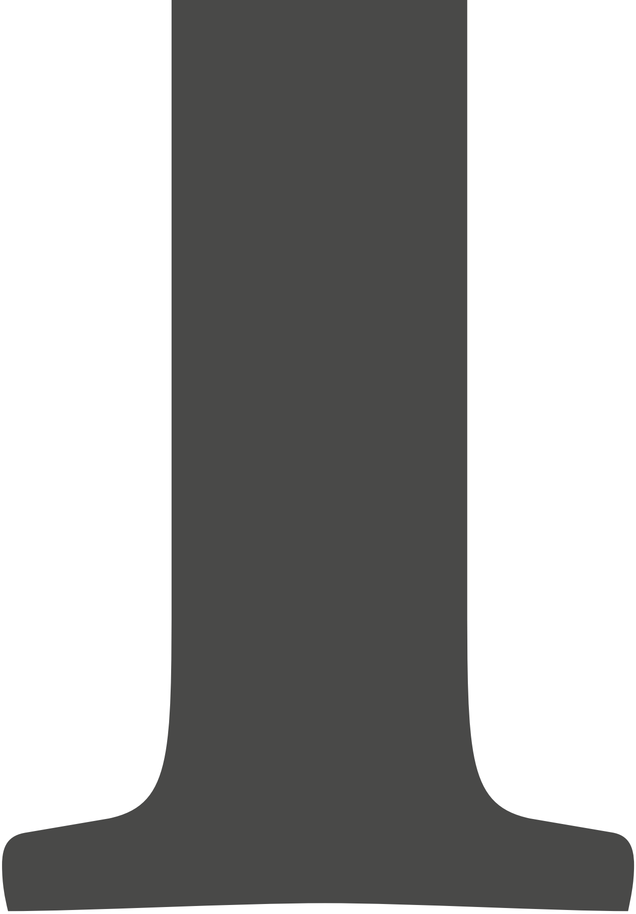


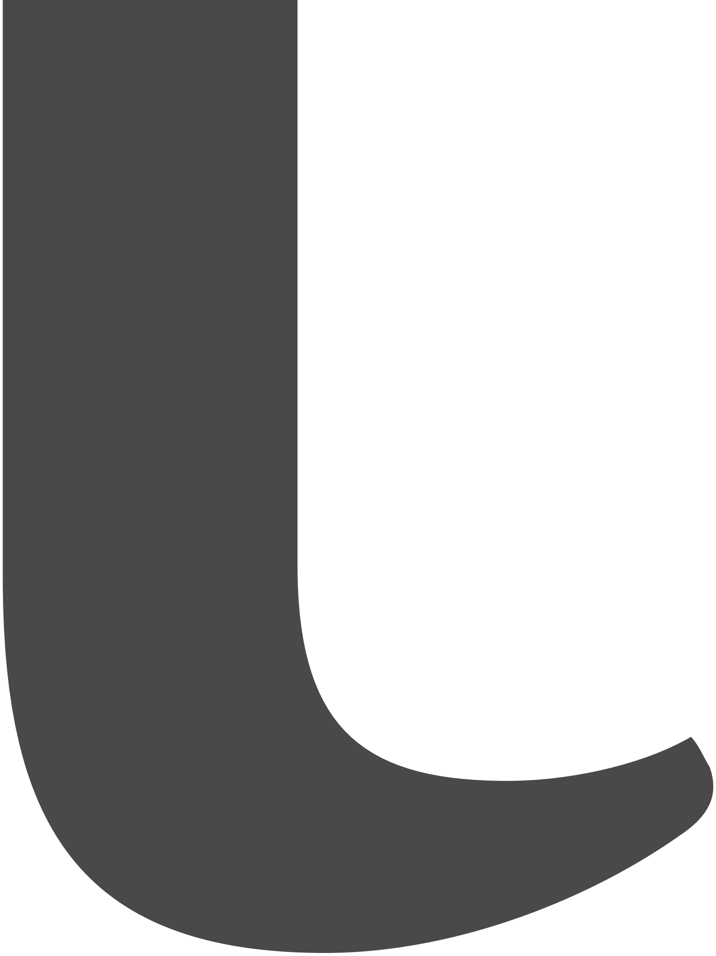


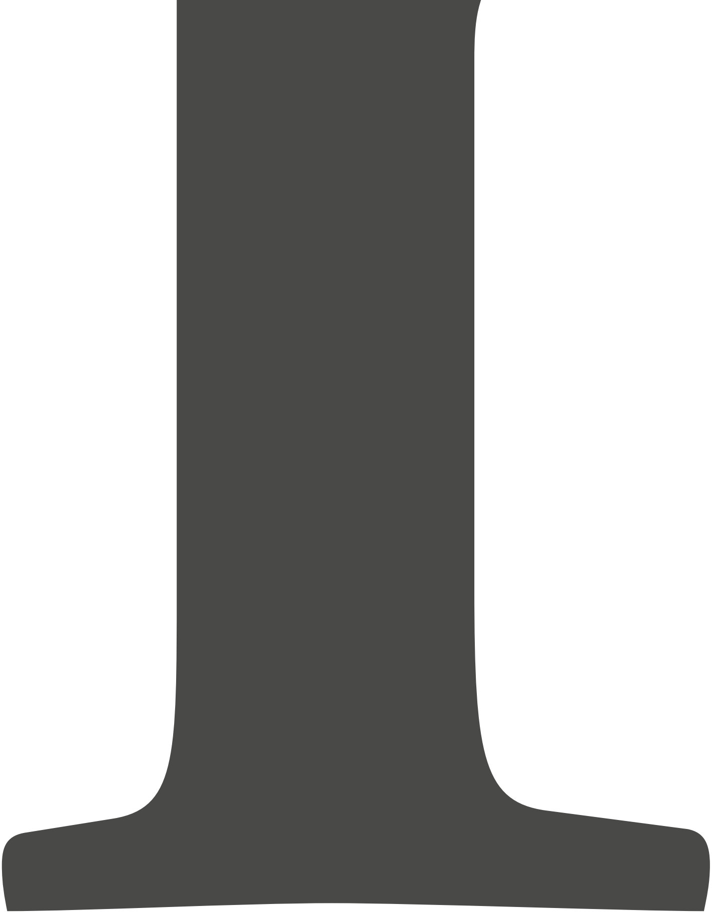


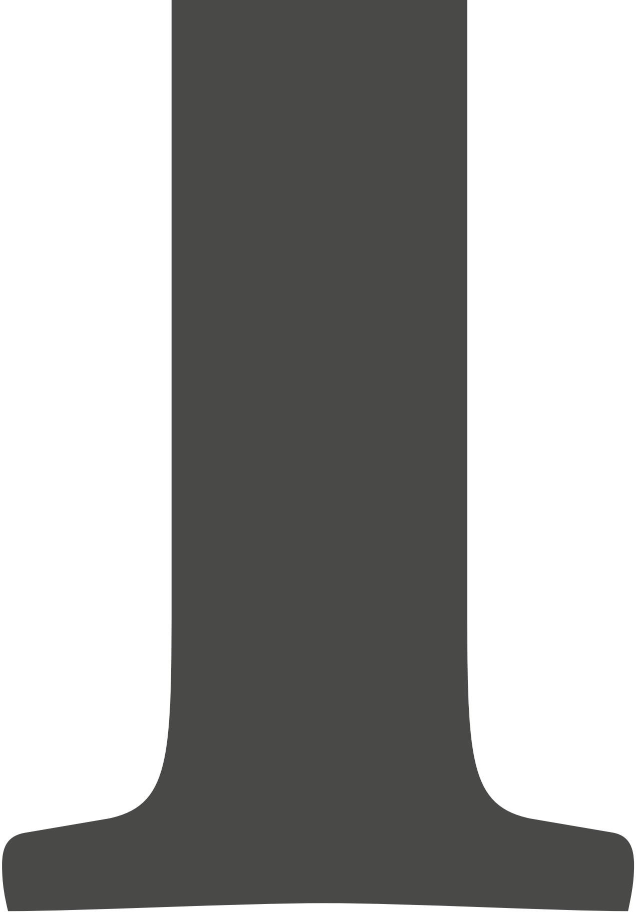
K

y

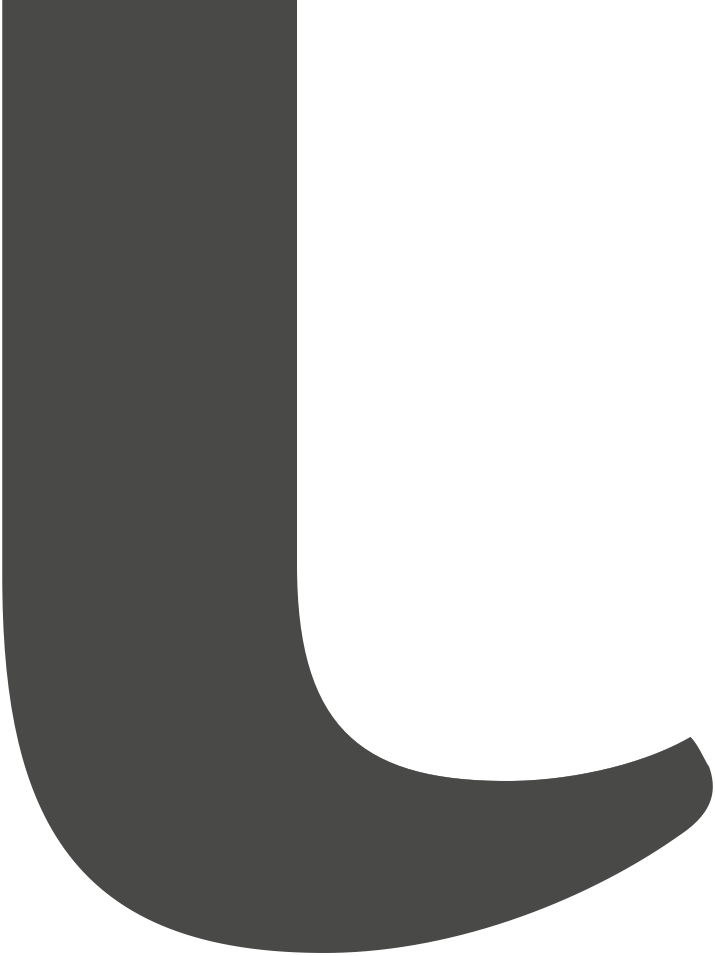


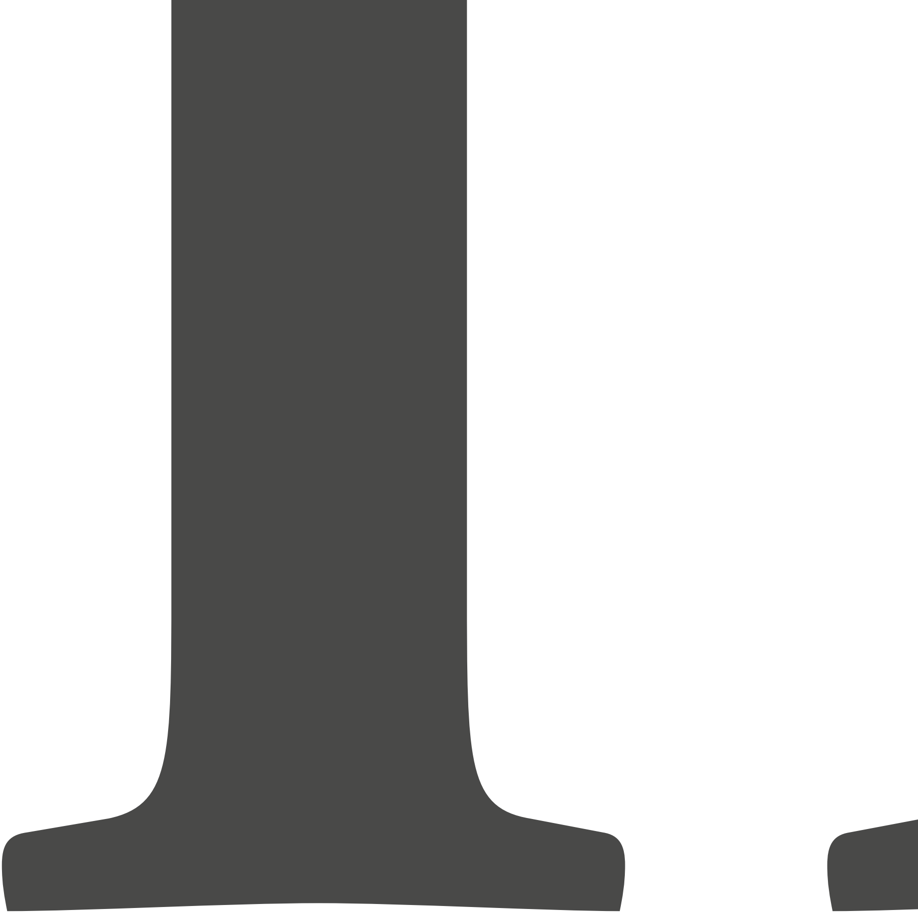


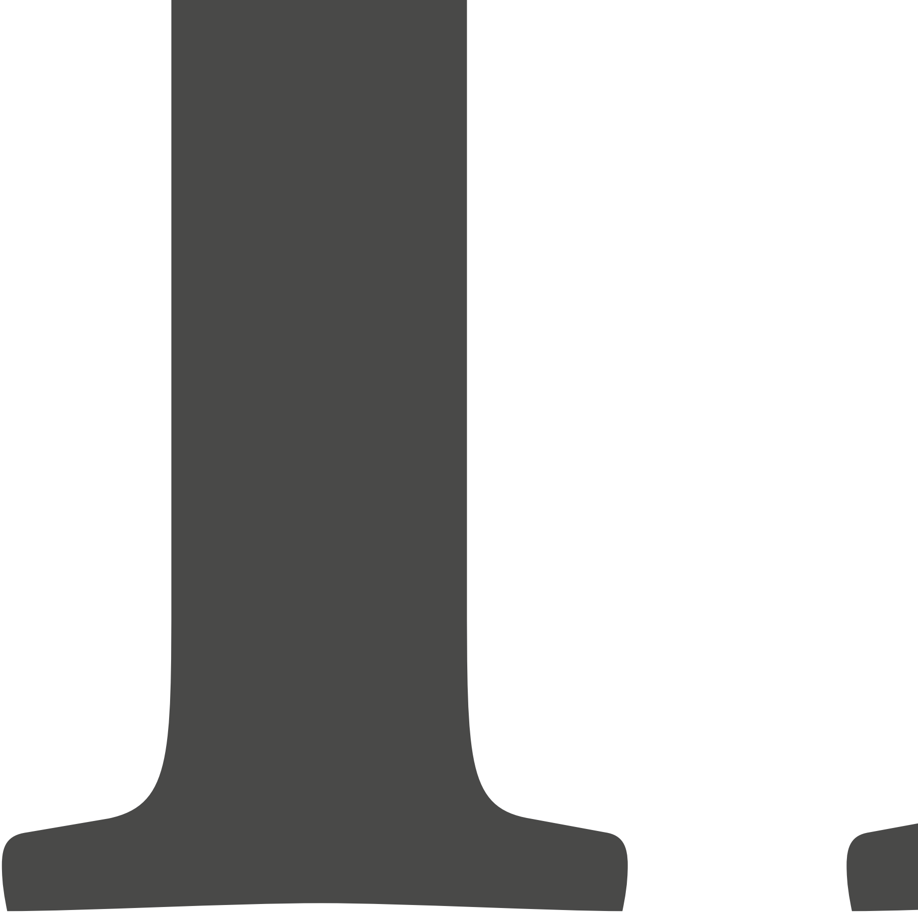


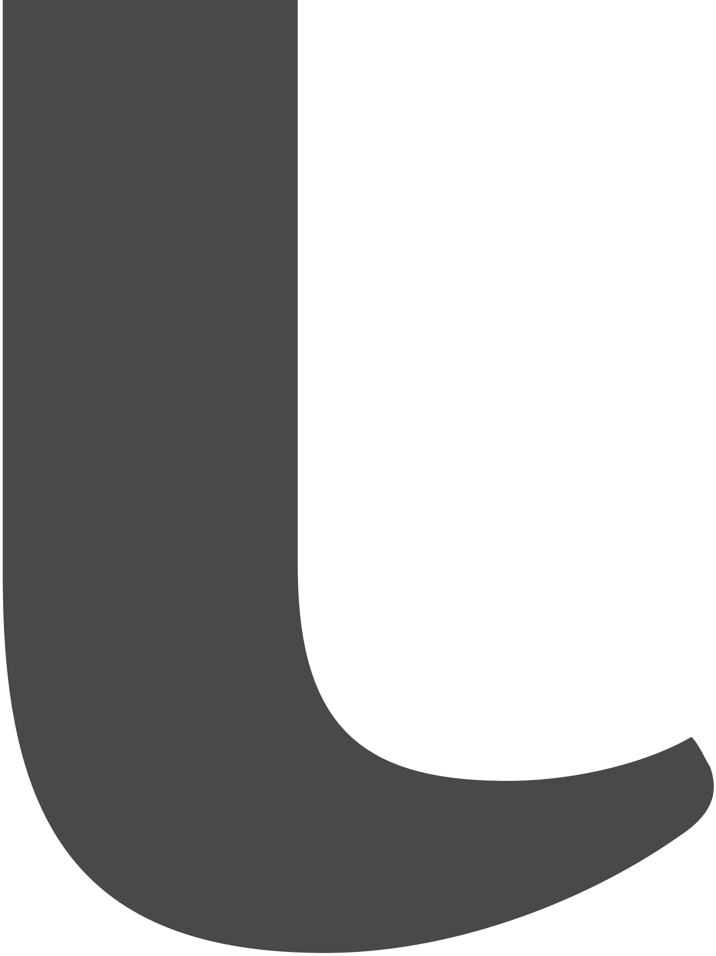


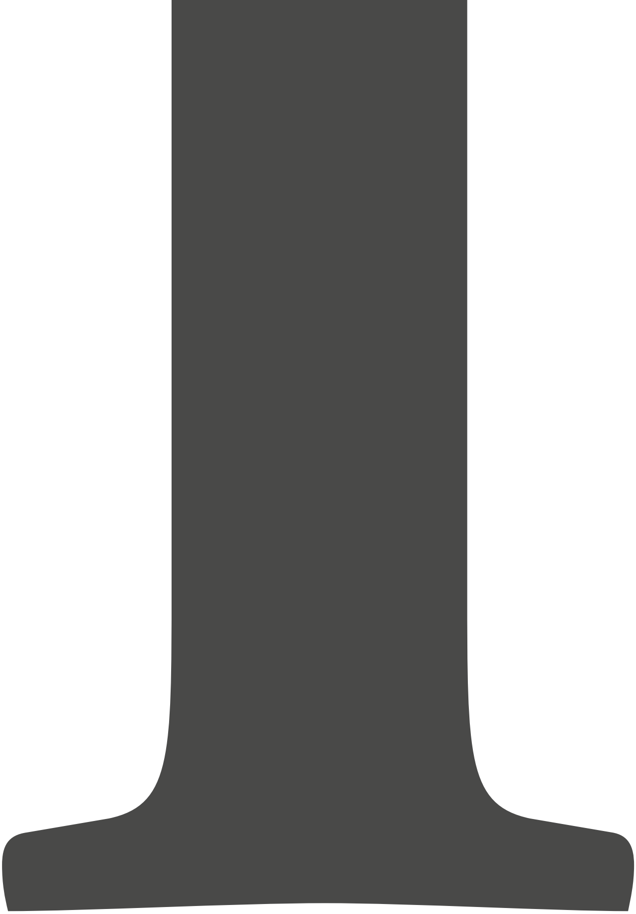
S

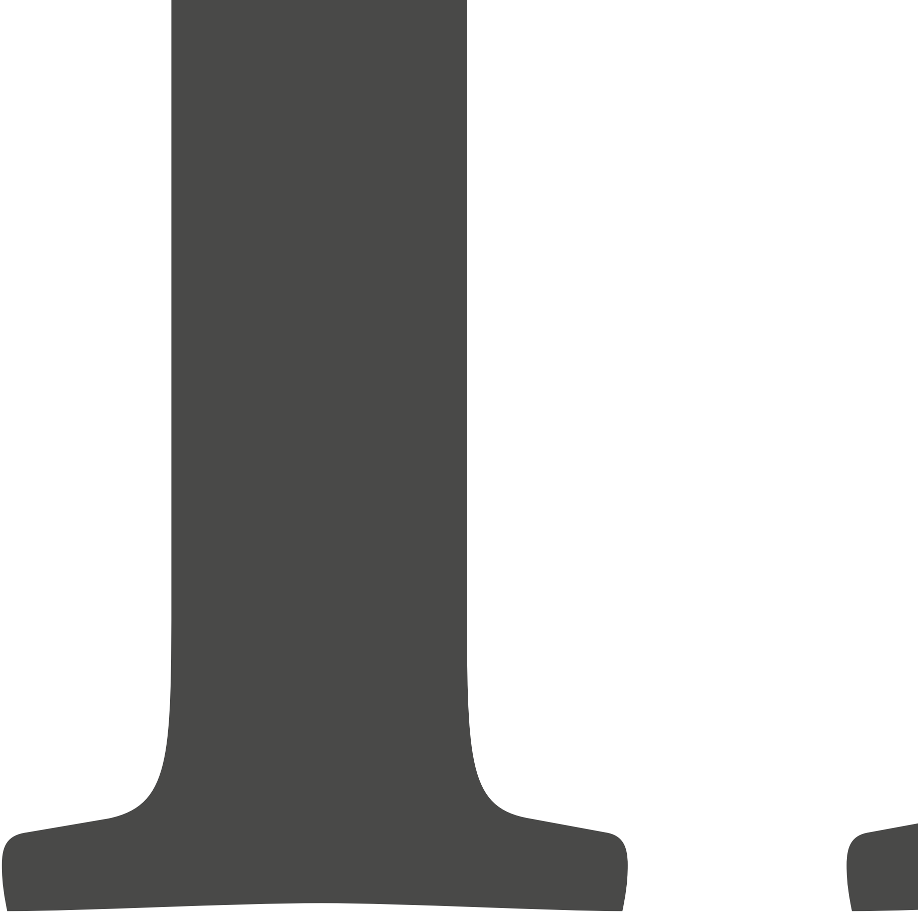


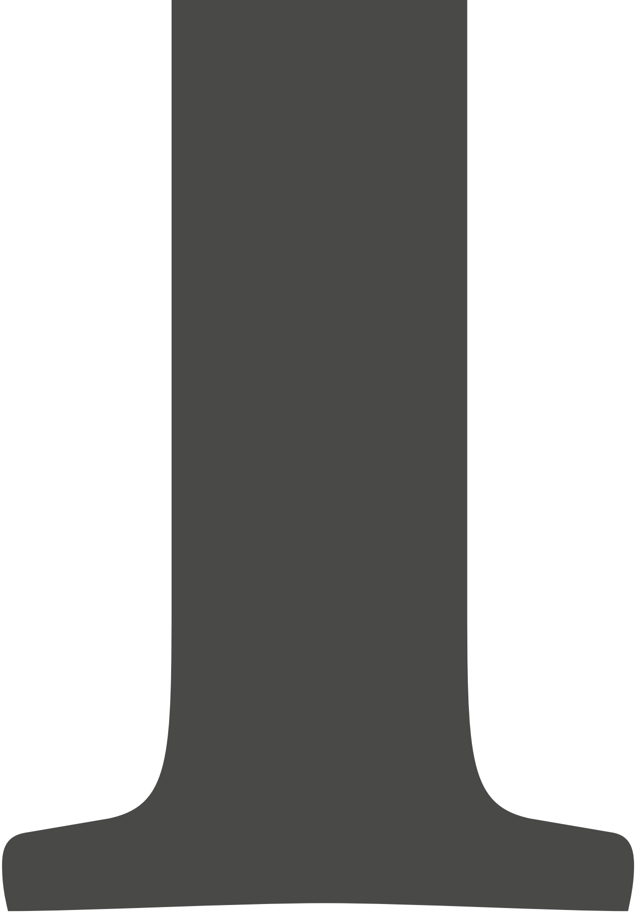


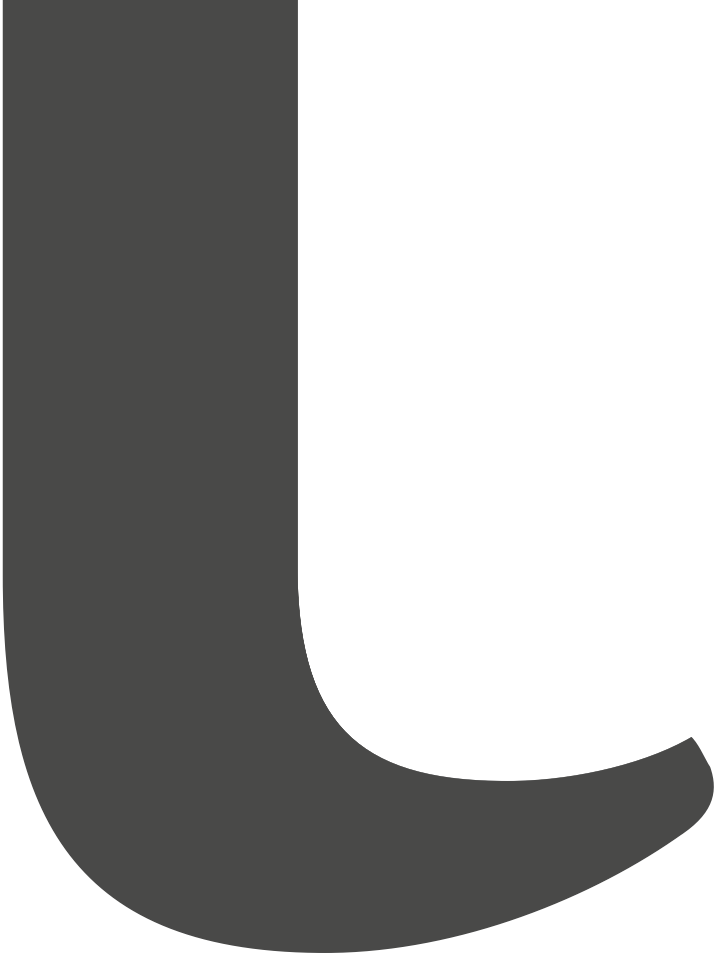




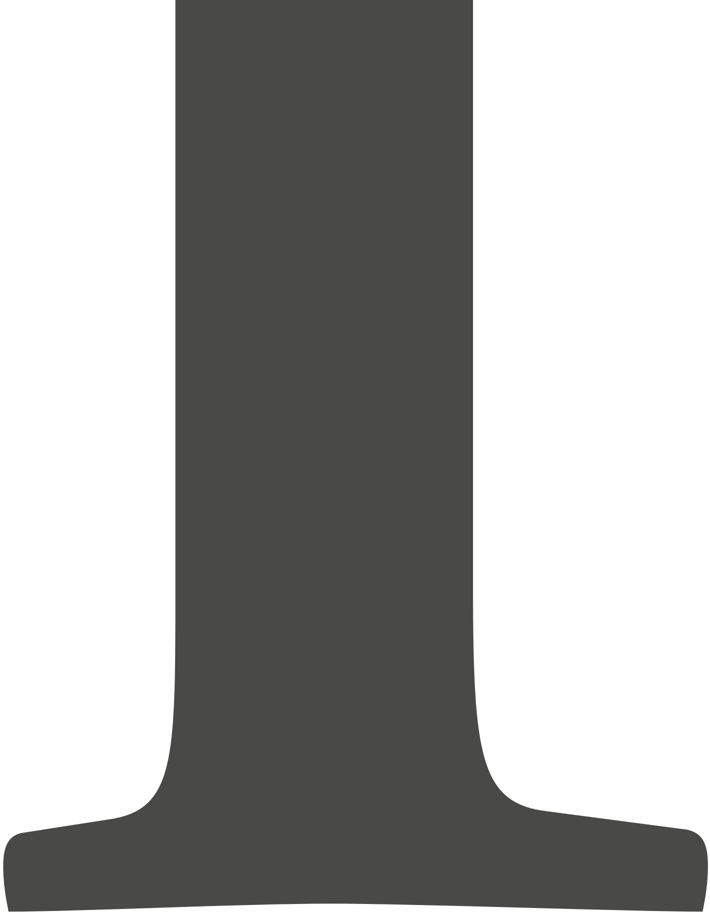


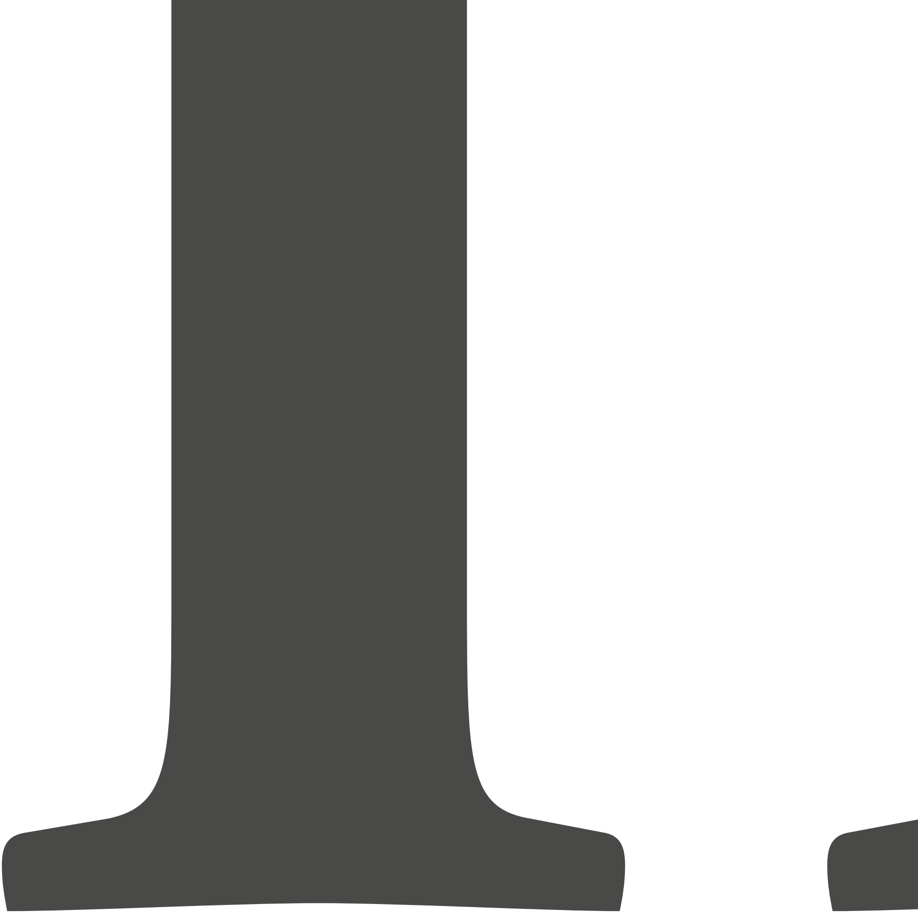


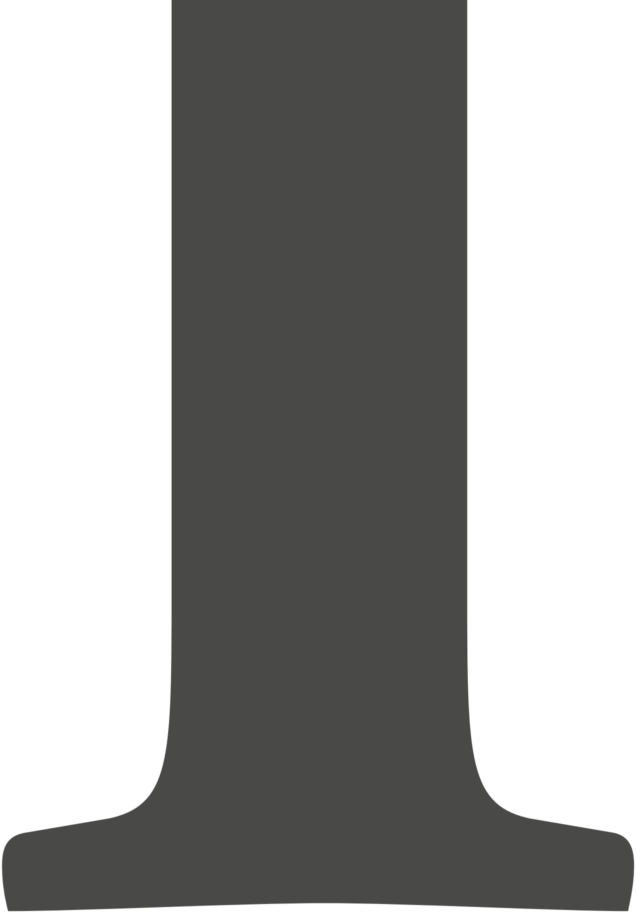


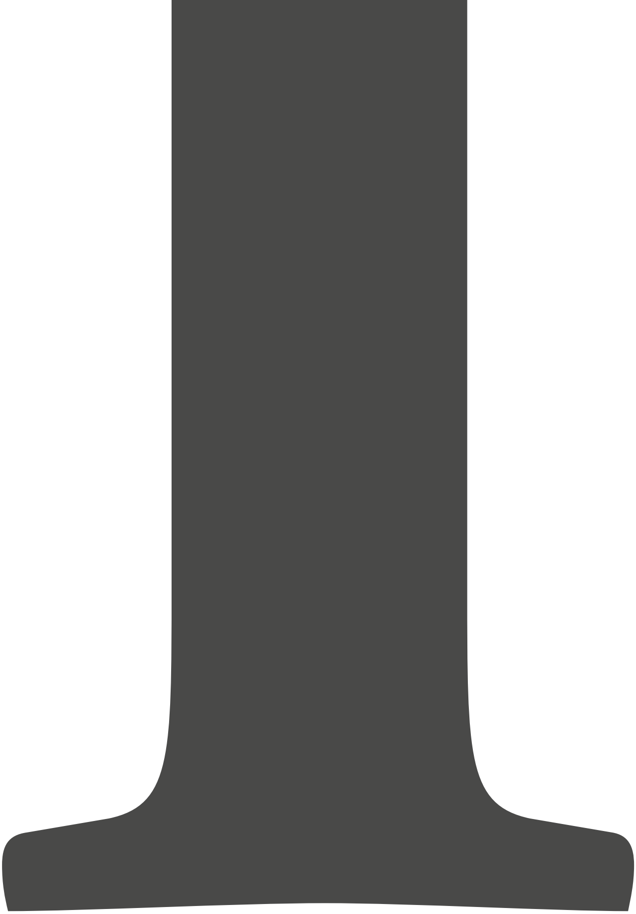


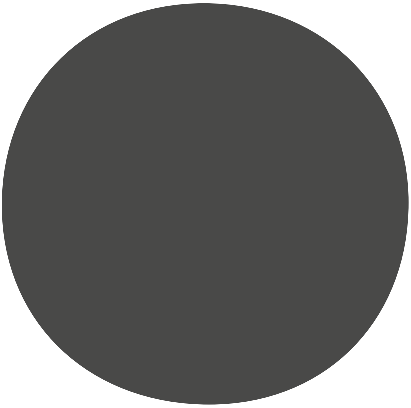
1



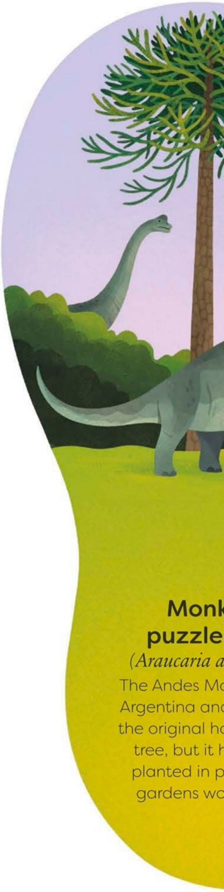




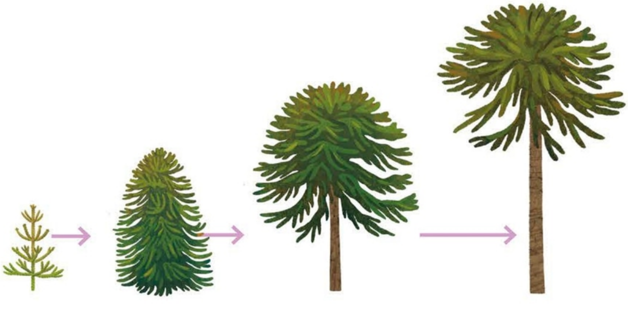




Monkey puzzle tree



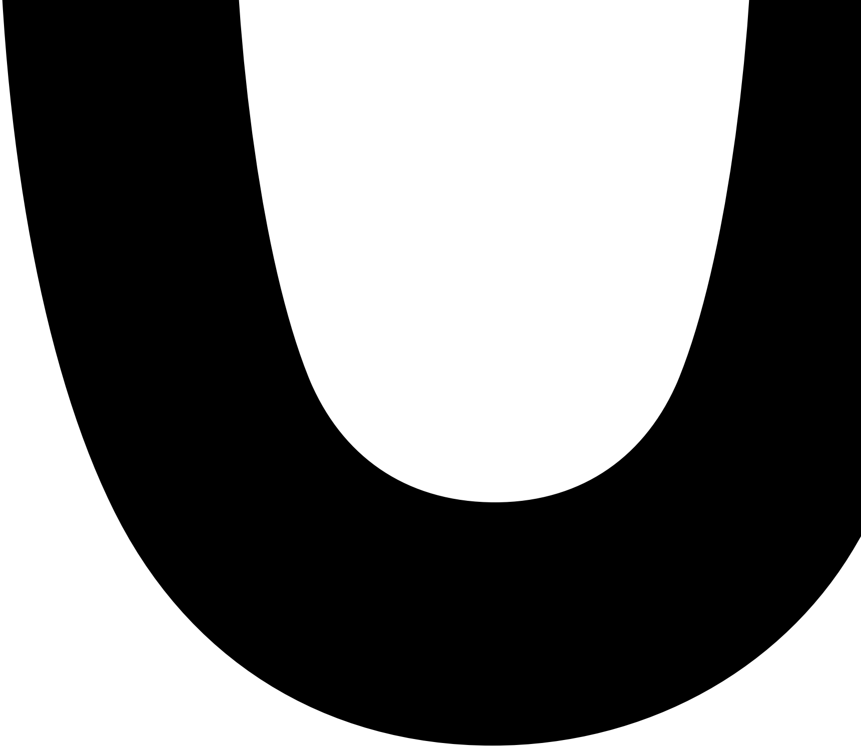
Monk
puzzle
(Araucaria a
The Andes Mo
Argentina and
the original ho
tree, but it h
planted in p
gardens wo



Changing shape

A monkey puzzle tree begi
growing like most other sap
However, as it gets older, th
lower branches drop off. Af
hundreds of years, the mat
tree has a tall, straight trun
all of its branches at the to

IV



K

[redacted]

U

4

[redacted]

A

g

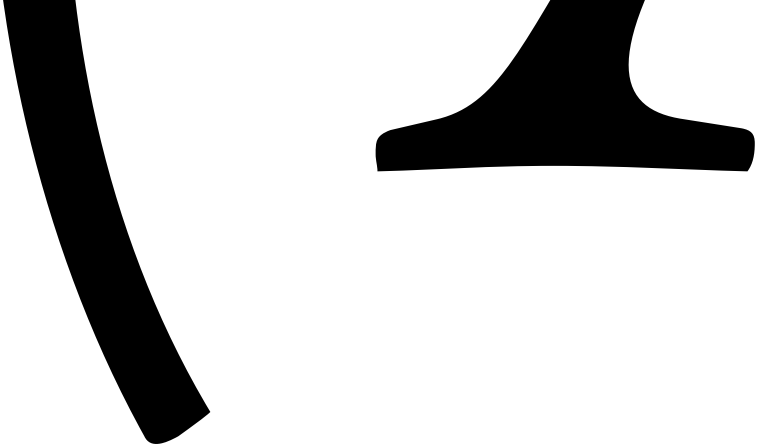
H

lo

h

tr

a



T

A

th

tr

p

g

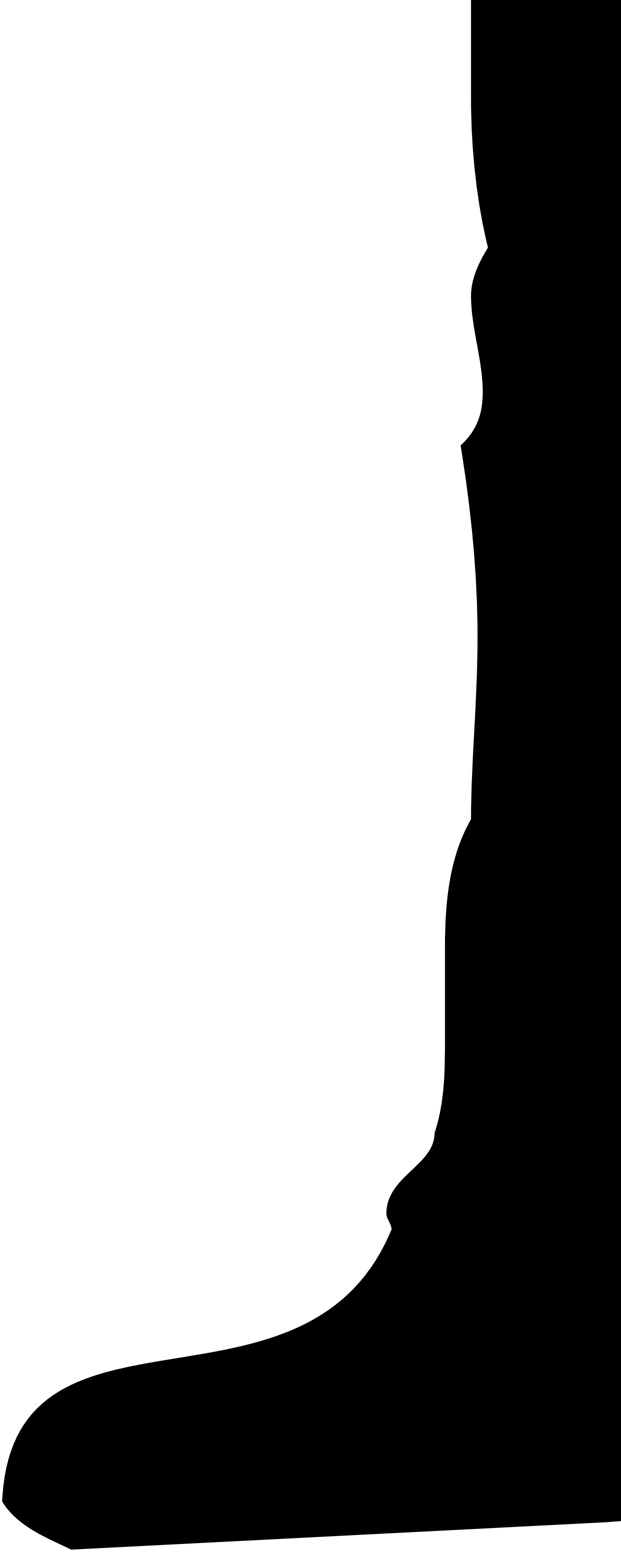
S

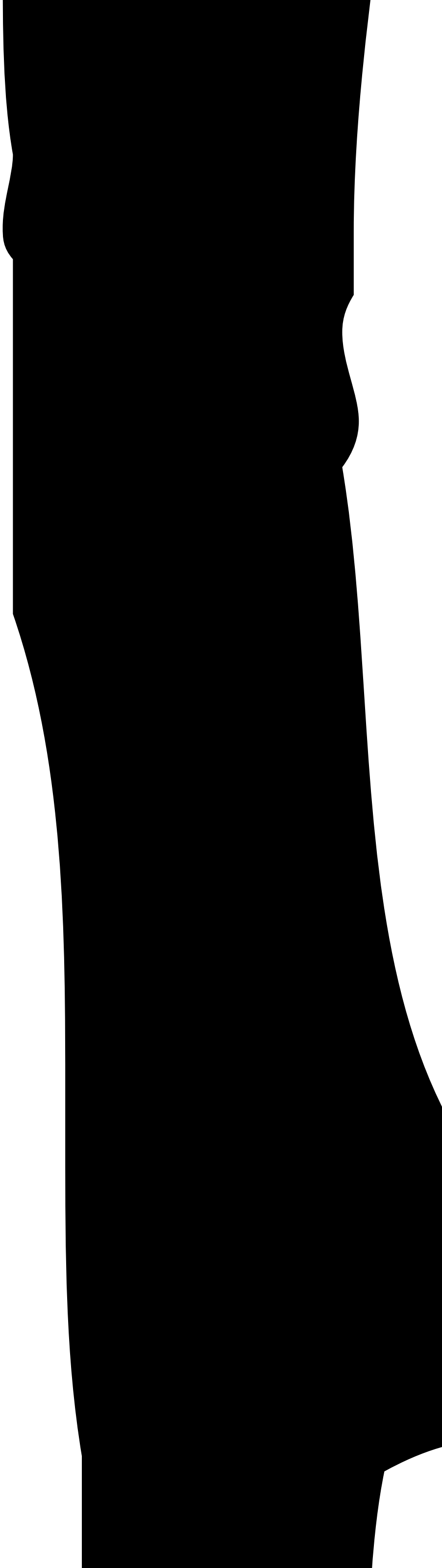
Y

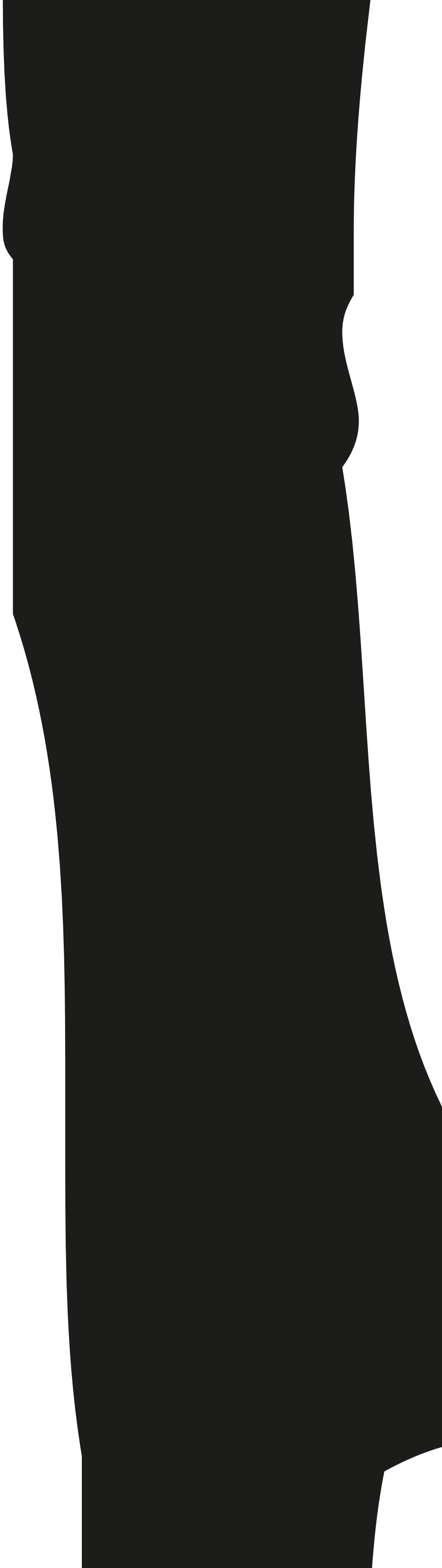
L

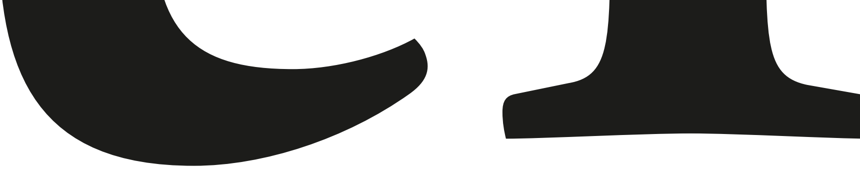
b

F









T

a

b

tr

W

D

d

fo

ch

T

ex

In

in

st

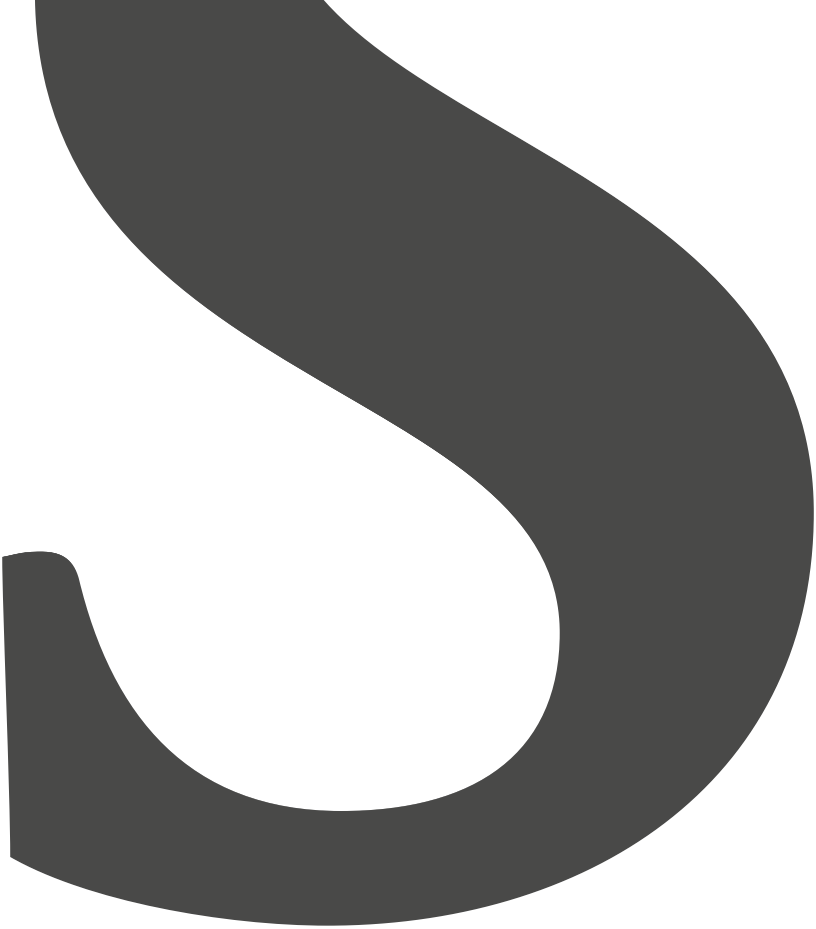
th

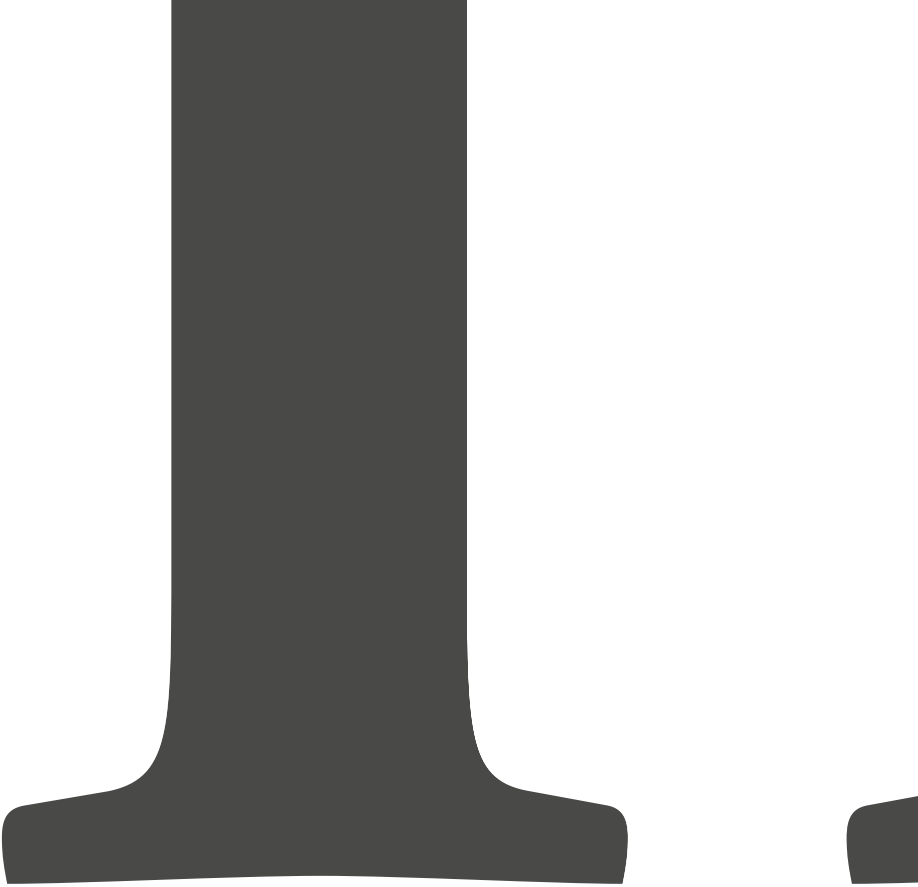
a

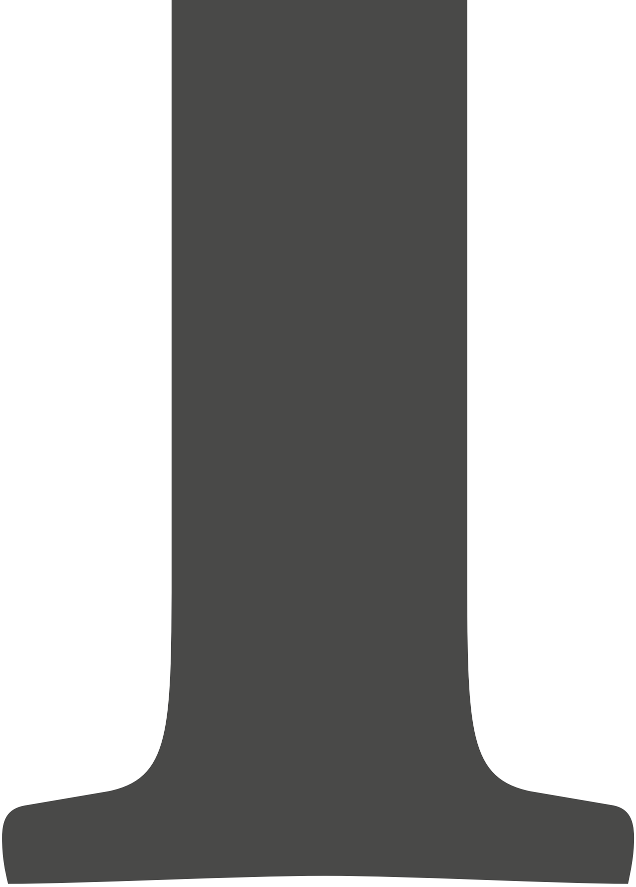
b

E

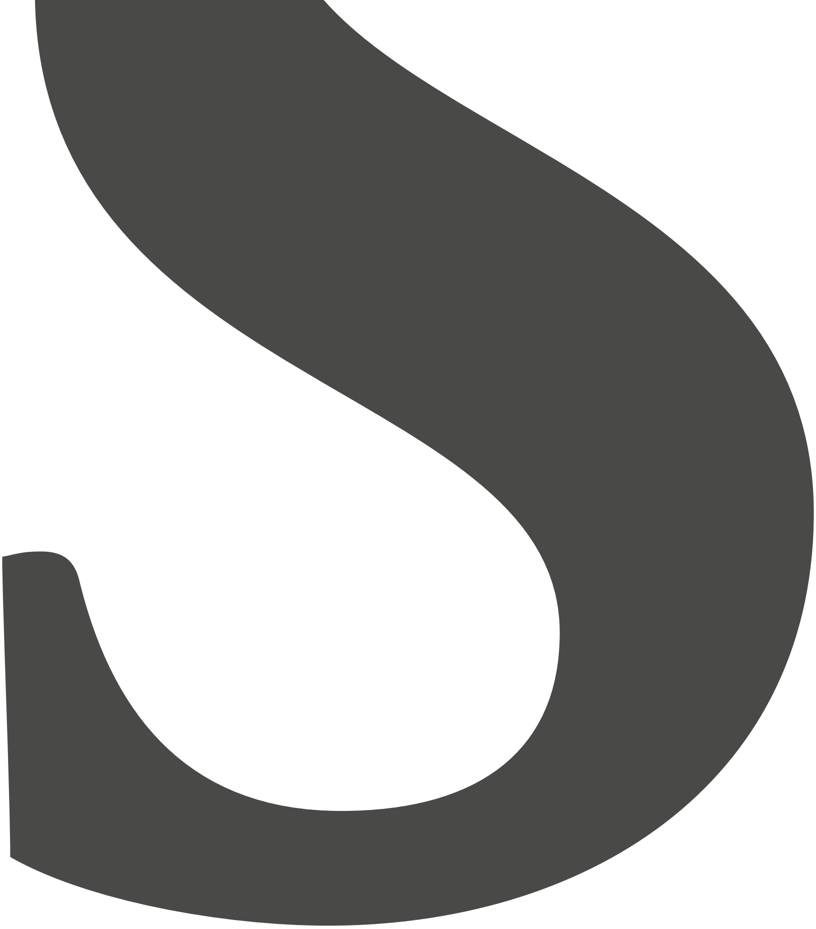
he

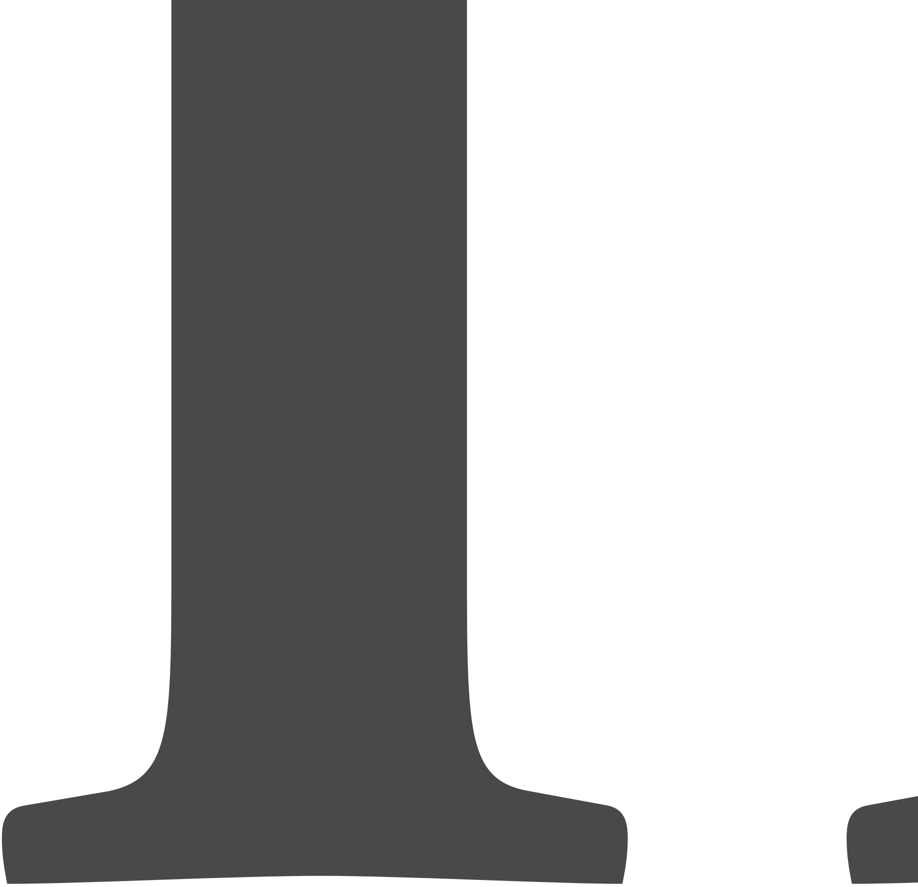


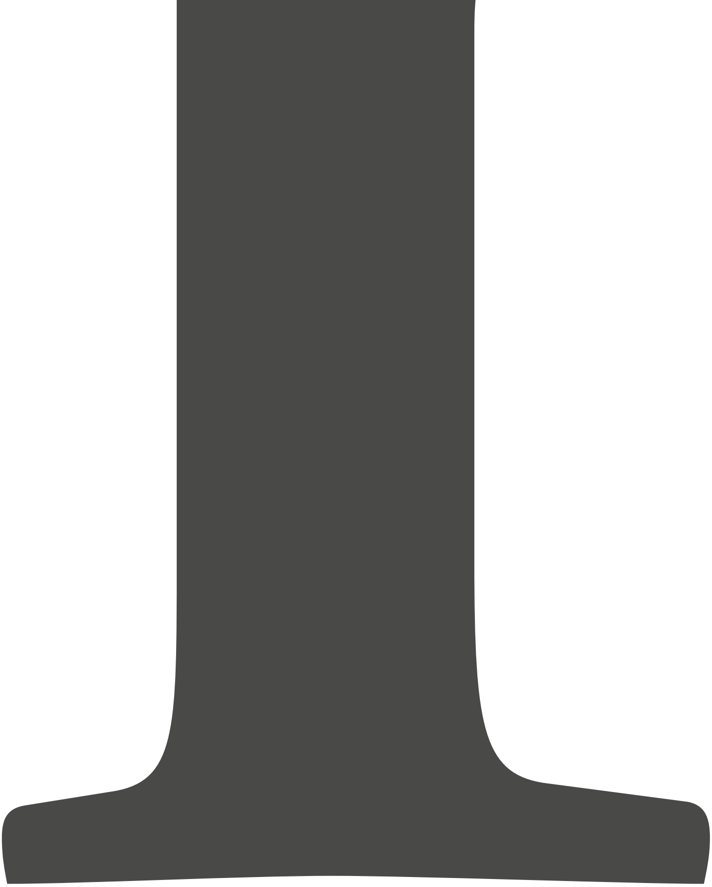


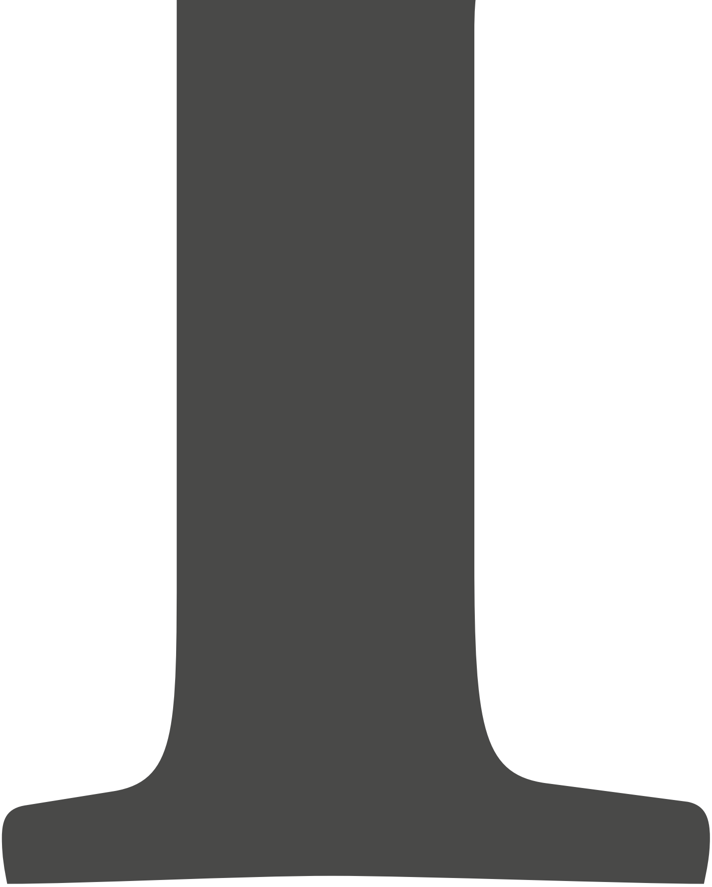


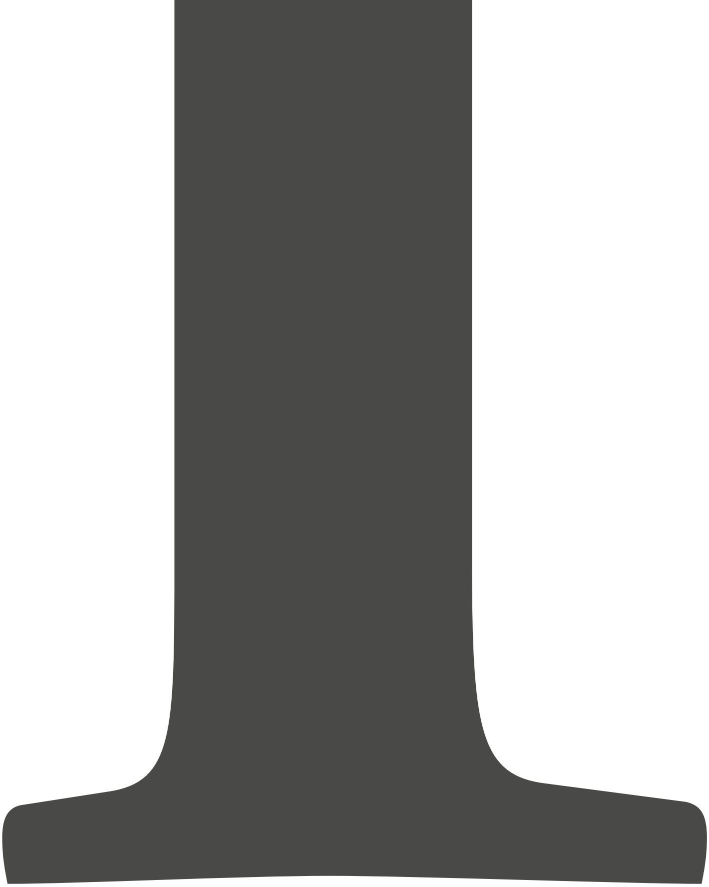
a

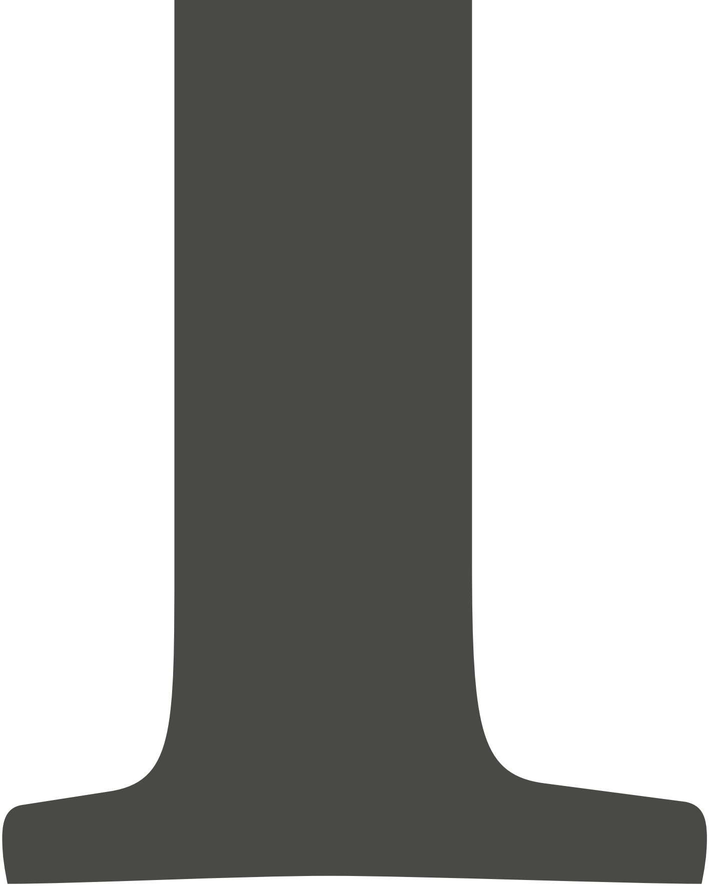


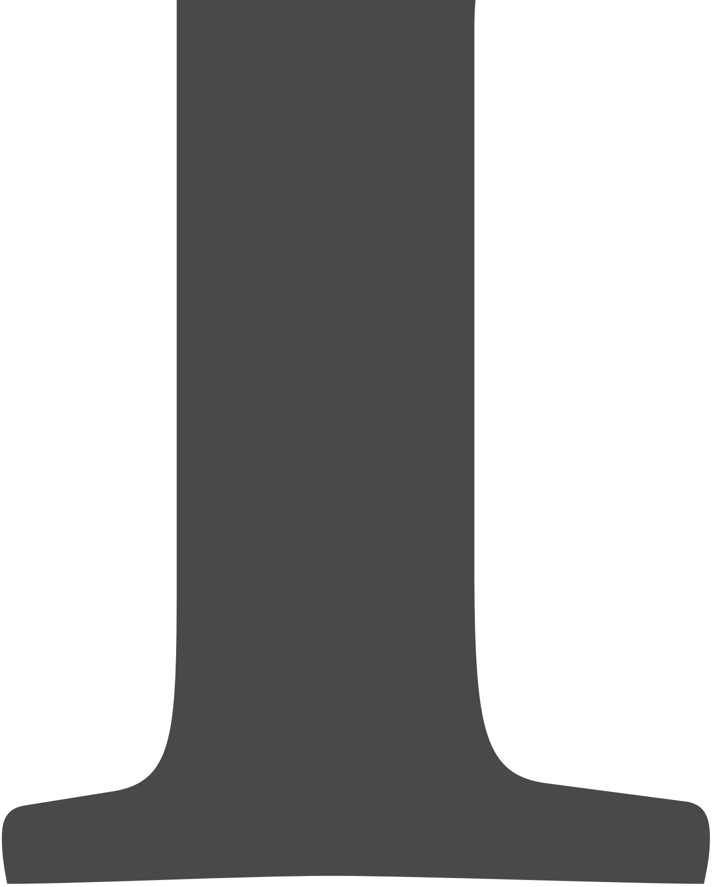


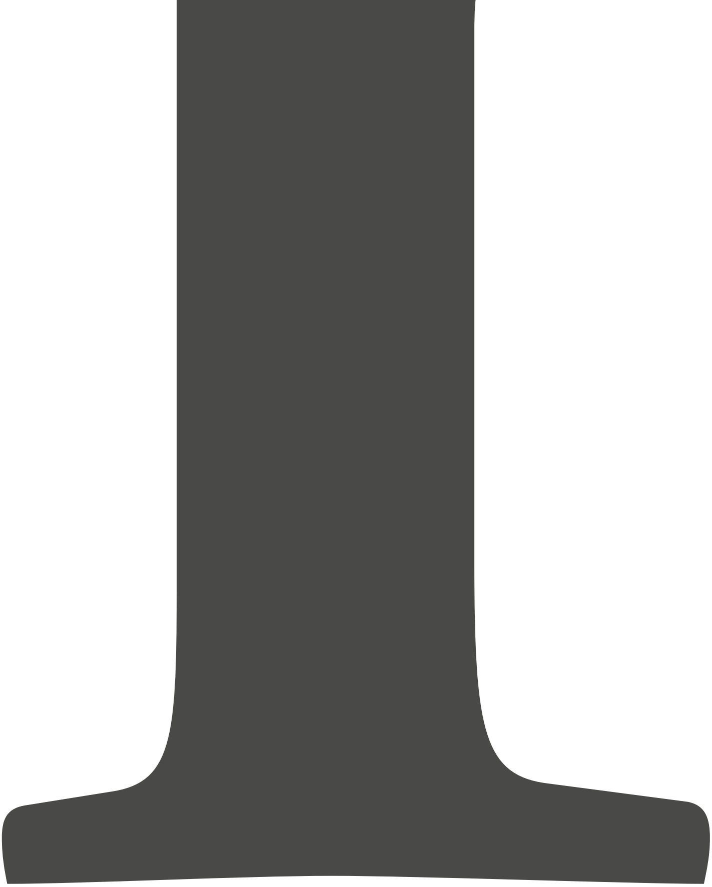




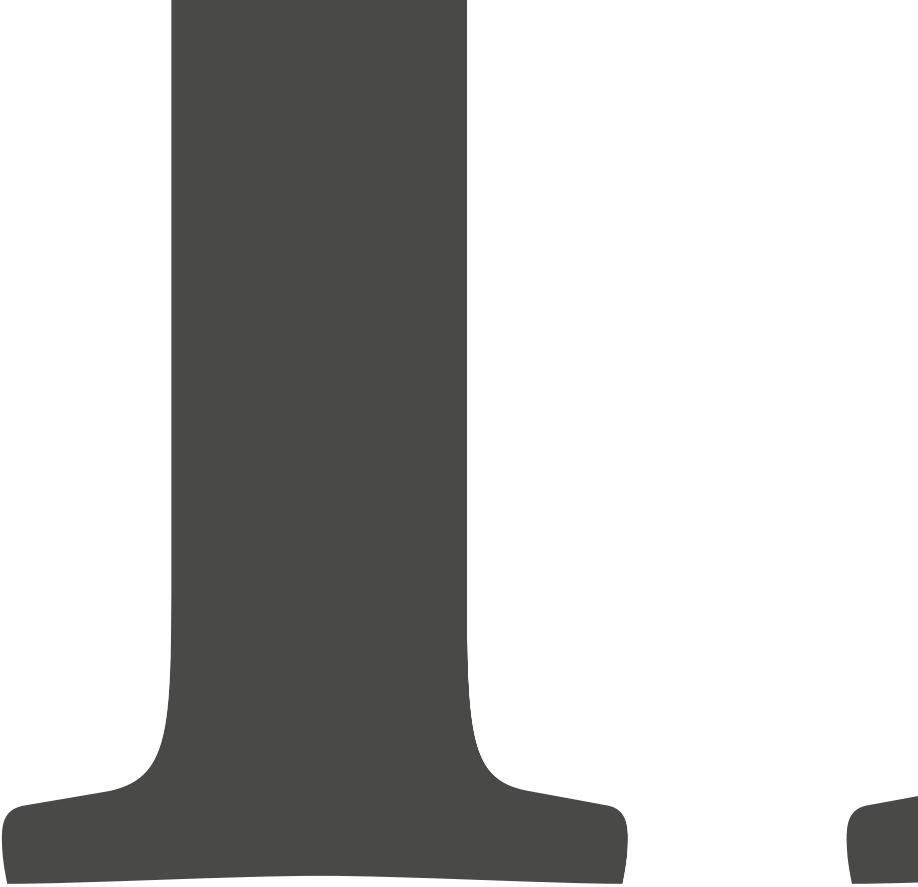


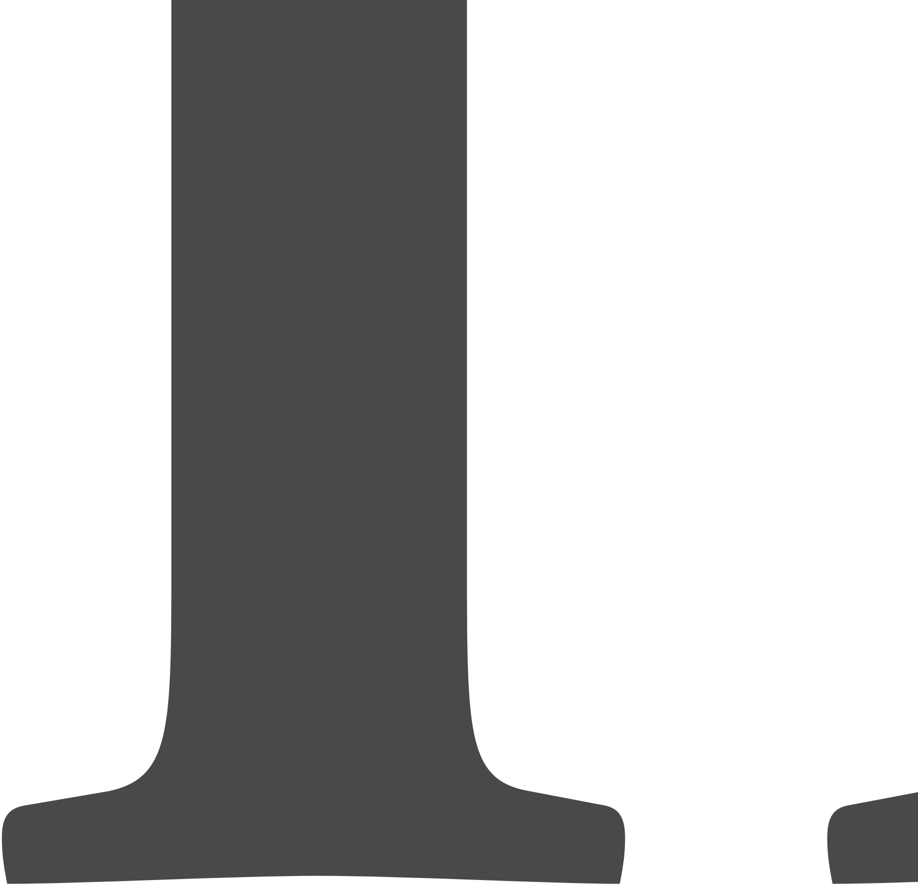


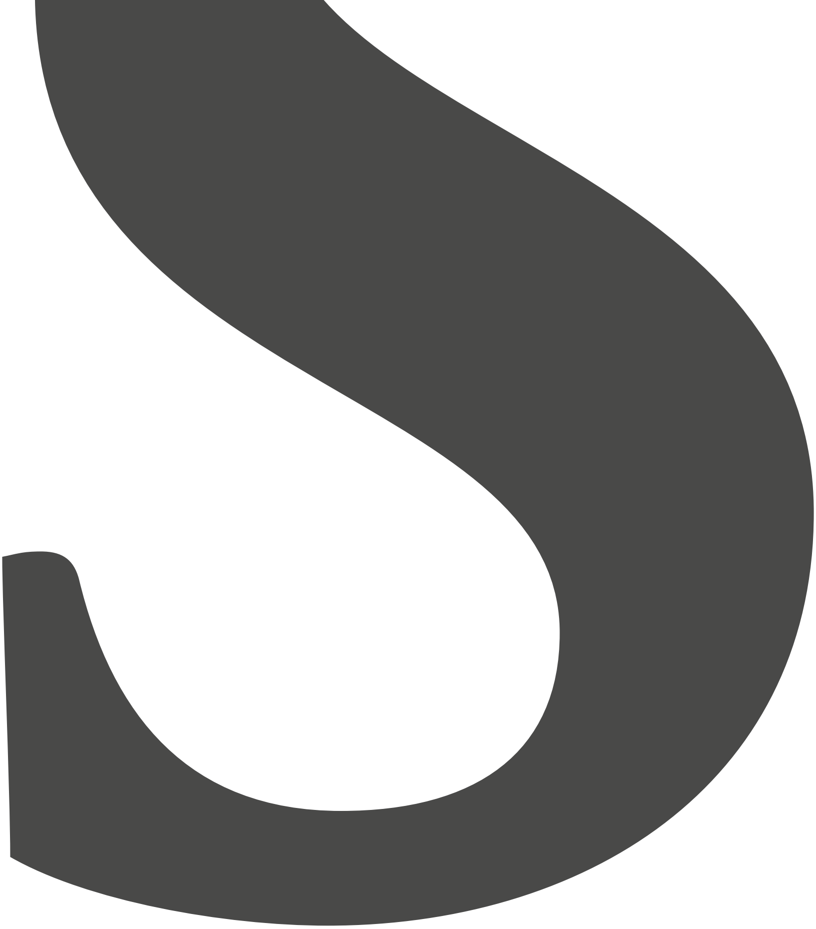


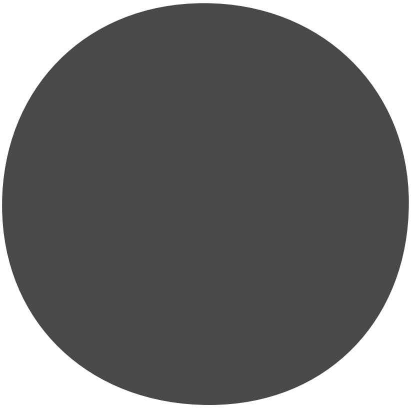


a

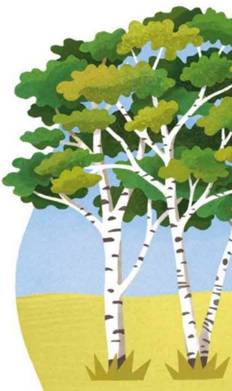




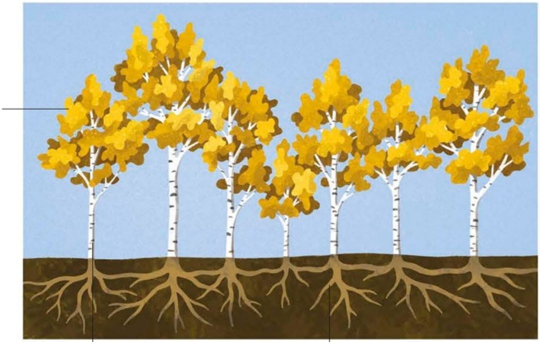




Quaking aspen



Quaking a
(Populus tremu
The quaking aspen
cool regions of Nort
often in mountains
Arctic to Mex



Root system
Young aspen trees shoot up from
roots belonging to the parent tre
and share the same root networ
The new trees, called clones, are
exact copies of the parent. In fall
their leaves all change color and
drop at the same time.

U

[redacted]

G

[redacted]

Y

r

a

T

e

th

d

T

C

O

A

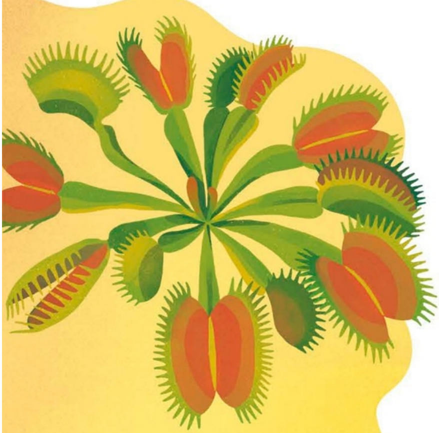
C

C

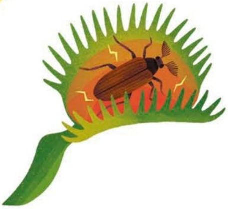
R

T

Venus flytrap

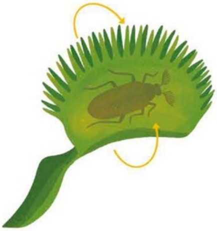


Venus flytrap
(Dionaea muscipula)
This carnivorous plant lives in wetlands on the east coast of the US. It is rare in the wild, but it is grown in large numbers to be sold as a house plant.



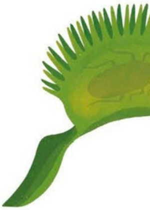
1) An insect arrives

A flytrap leaf is red and shiny inside and produces nectar. The bright color and sweet treat attract insects.



2) The trap shuts

The leaf waits for an insect to touch a trigger hair twice, or touch two hairs, within 20 seconds. Then it snaps shut.



3) Digestion be

As the insect touches m
hairs, the closed leaf fil
digestive juices to disso
week or so later, it ope

A

in

T

tr

T

t

o

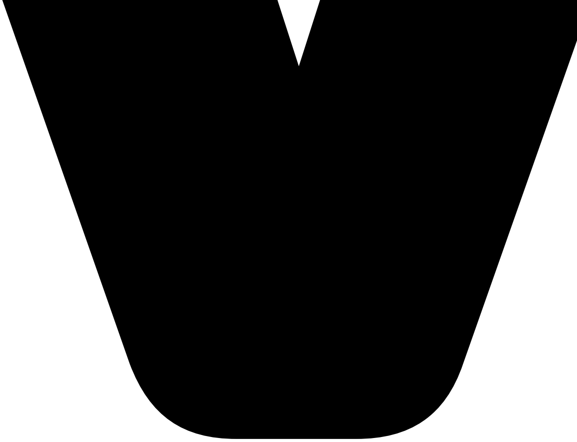
2

A

h

d

w



([illegible]

T

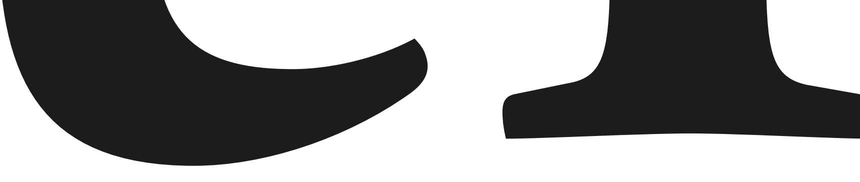
in

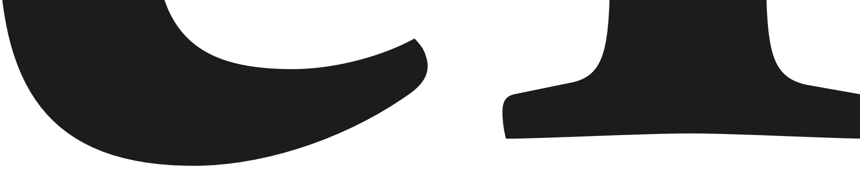
C

th

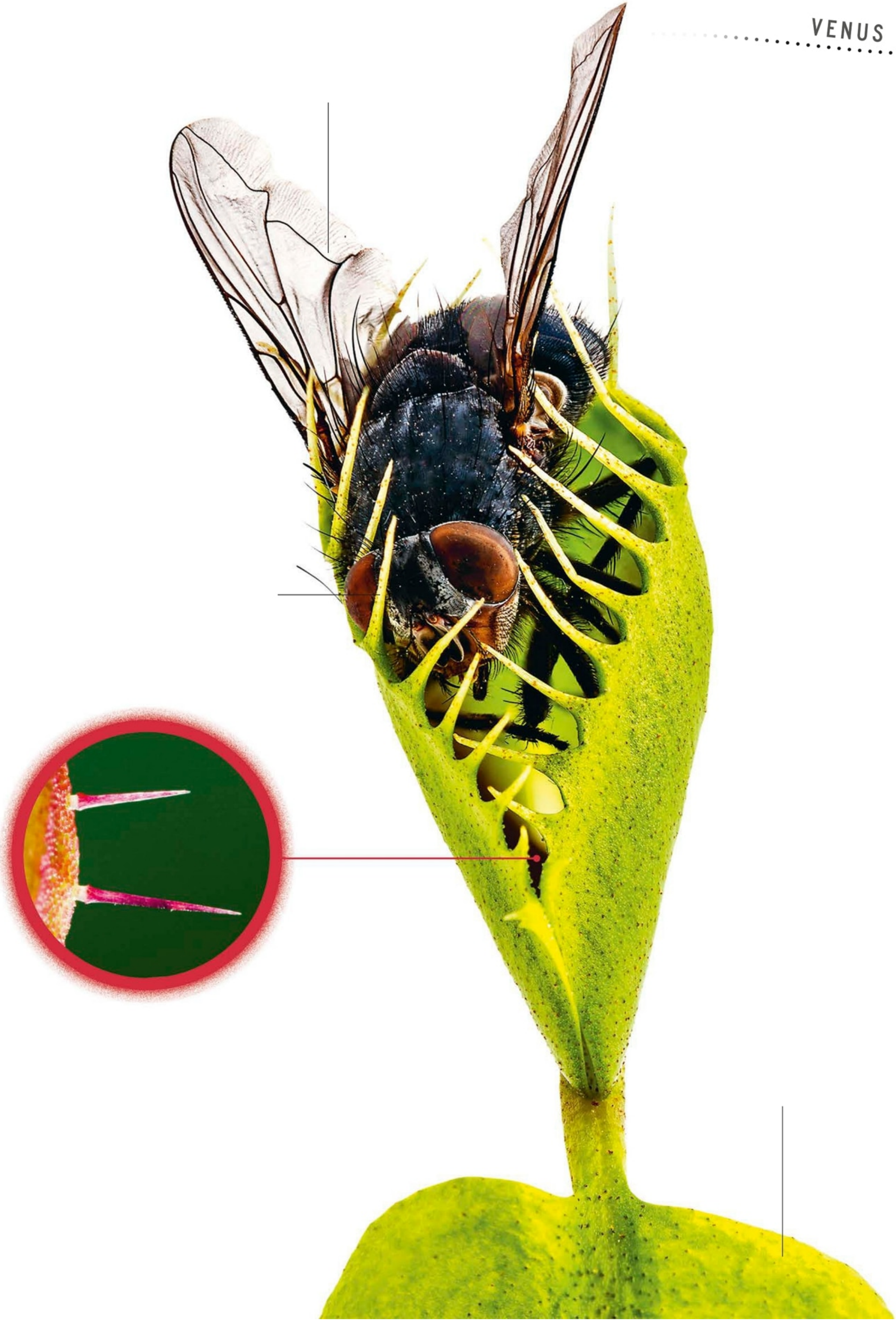
l

a





VENUS F



V

U

[redacted]

[redacted]

[redacted]

l

a

lf

th

le

E

a

h

b

a

Sh

of

to

es

T

a

le

w

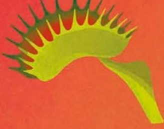
T

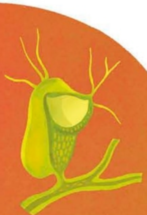
is

O

1

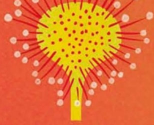
1

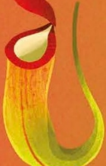


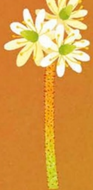


Types of trap

Some plants have active traps that snap shut on insects or suck them in. Others wait for victims to stick to their leaves and stems, or drop into pitfall traps. A few have underground leaves that catch worms.





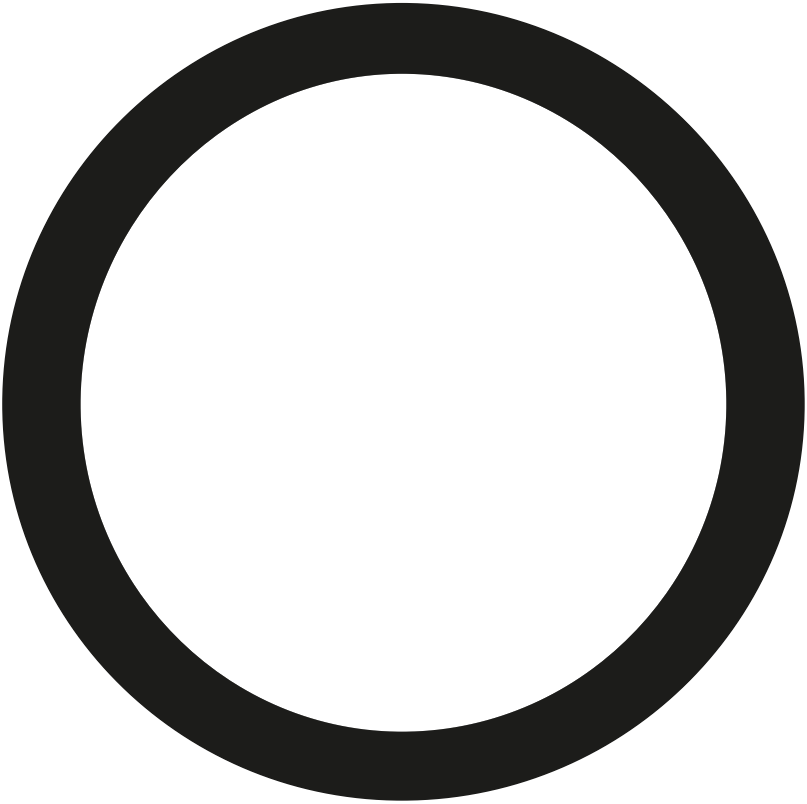


P

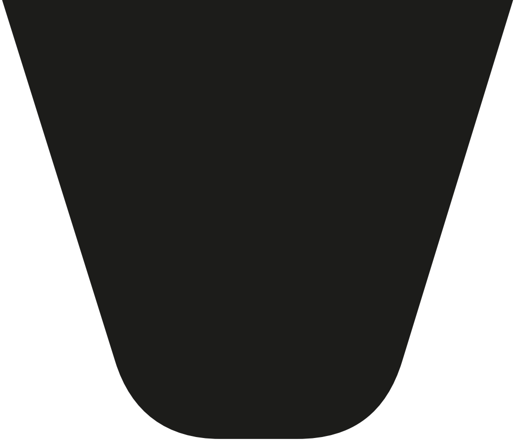
le

l

Sl



p



E

p

lo

in

th

h

th

fr

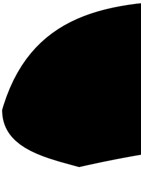
P

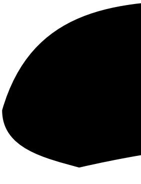
S

S

S

le





Th

le

3

Th

a

ne

a

Meat-eating plants

IV

[redacted]

[redacted]

[redacted]

N

[redacted]

[redacted]

B

a

SU

S

b

T

le

T

a

in

S

a

t

g

d

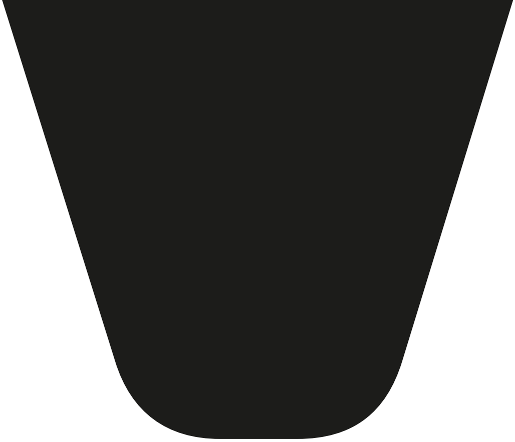
T

y

“h

th

b



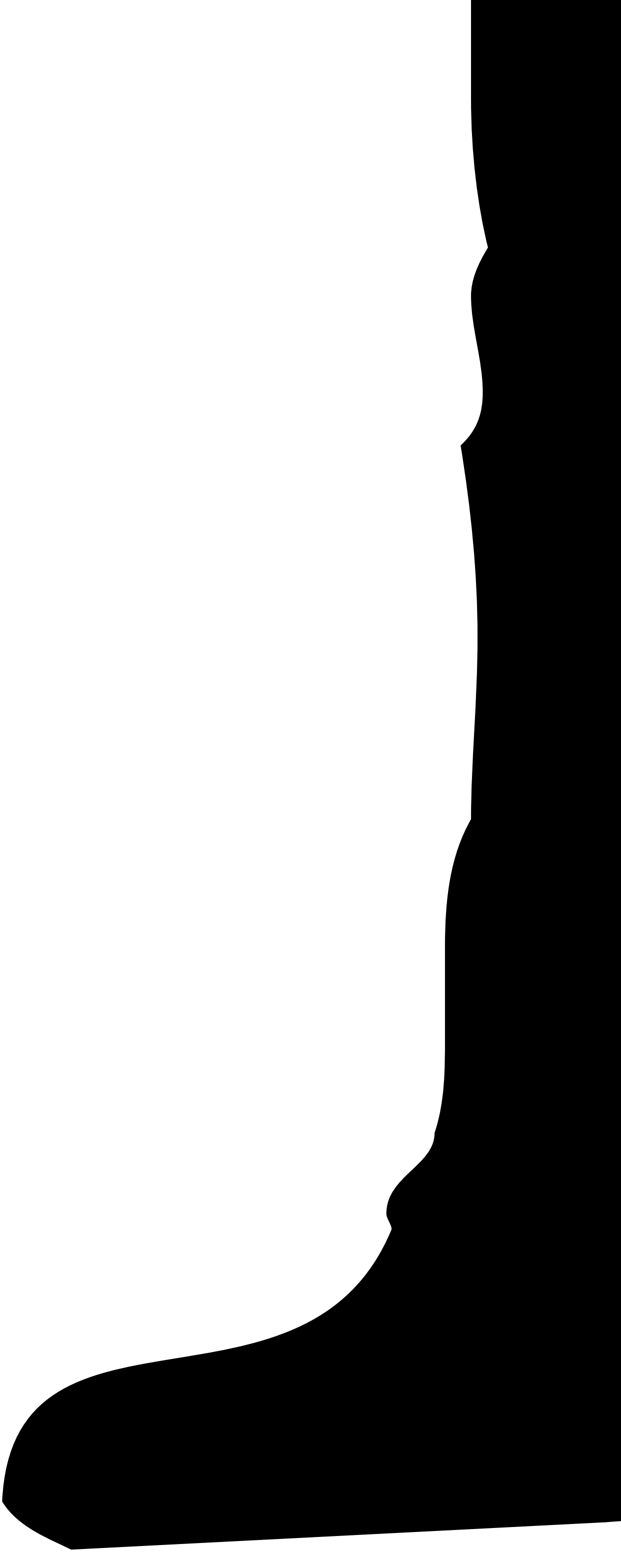
T

a

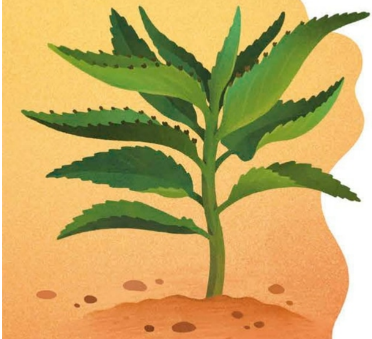
W

W

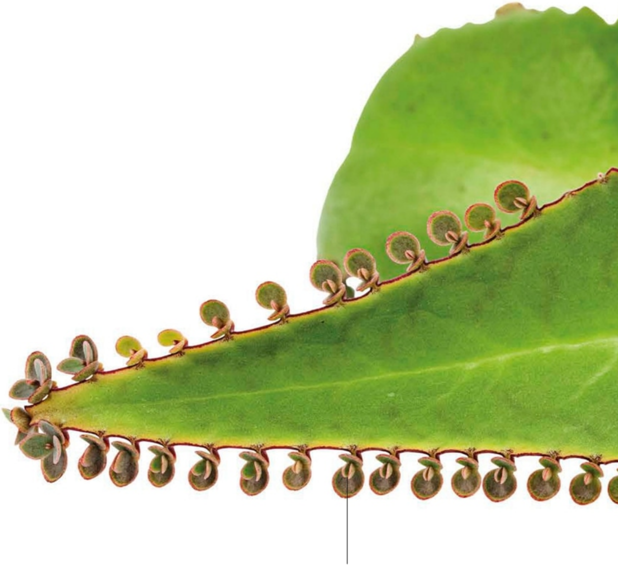
W

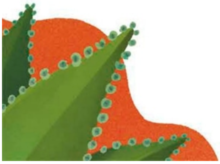


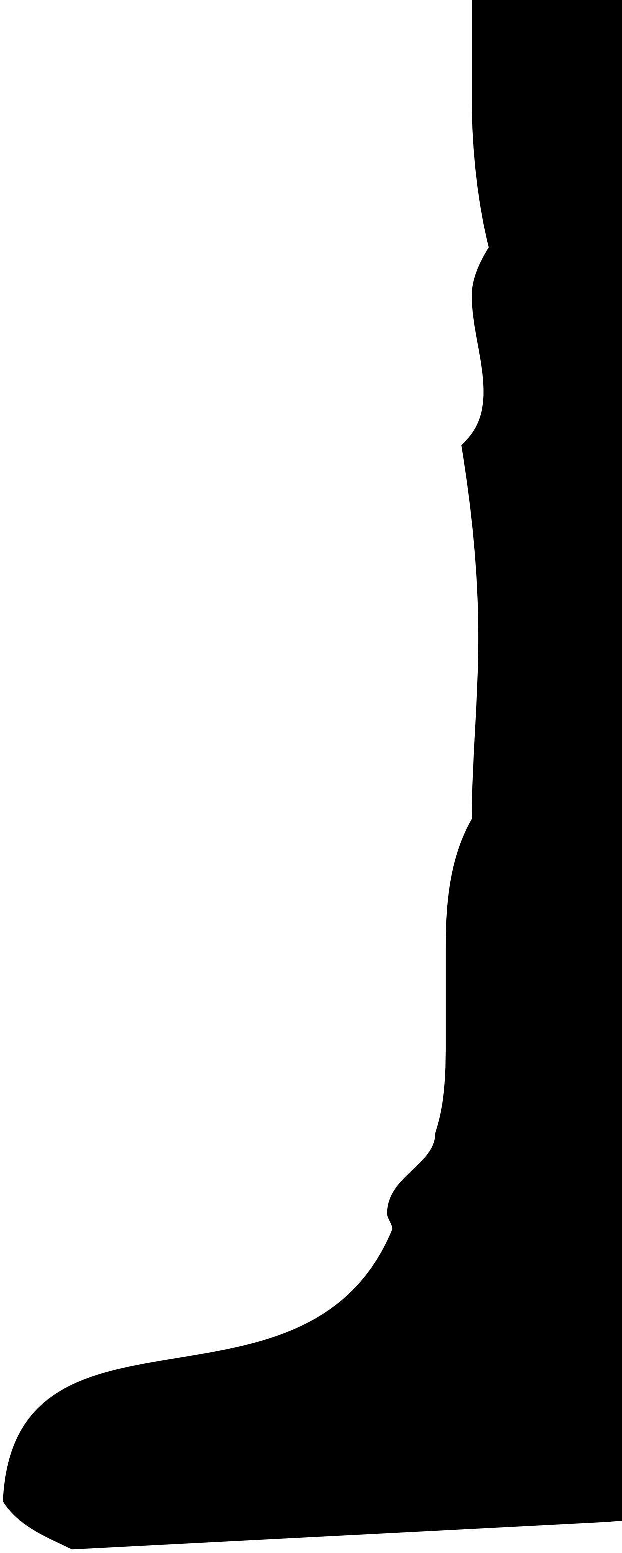
Mother of thousands

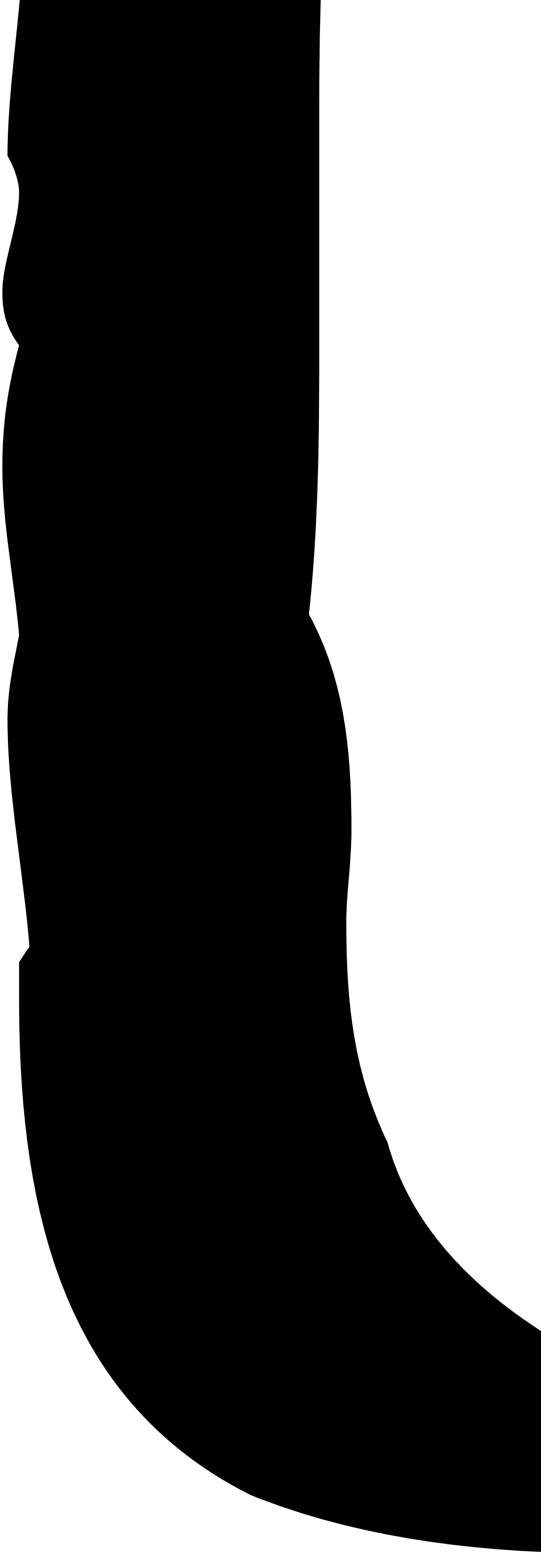


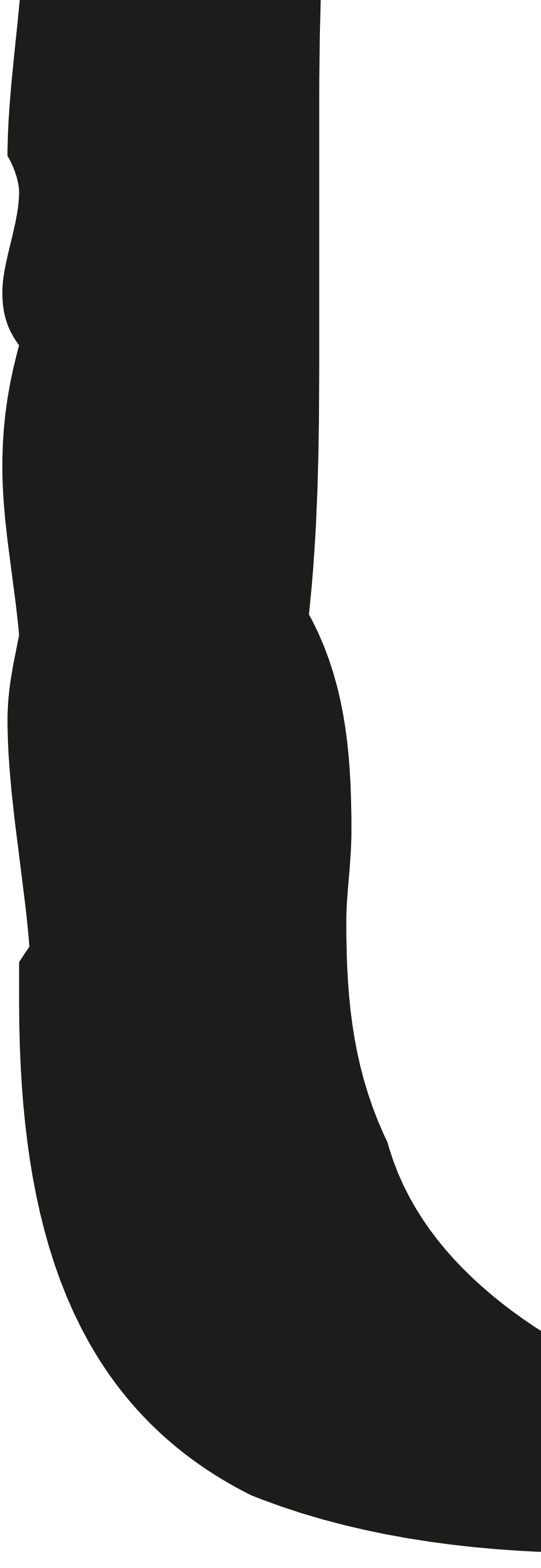
Mother of thousands
(Kalanchoe daigremontiana)
This type of Kalanchoe comes from the island of Madagascar, off the east coast of Africa. Although poisonous, it is a popular house plant because it can survive with little water.

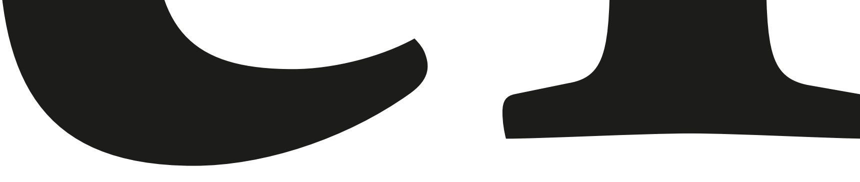


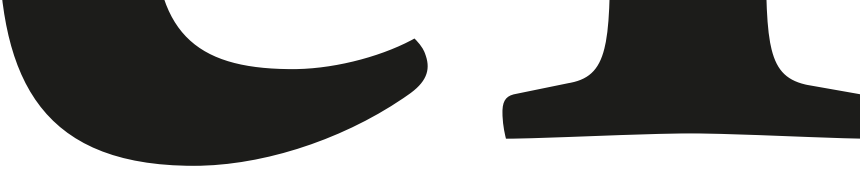












([illegible]

T

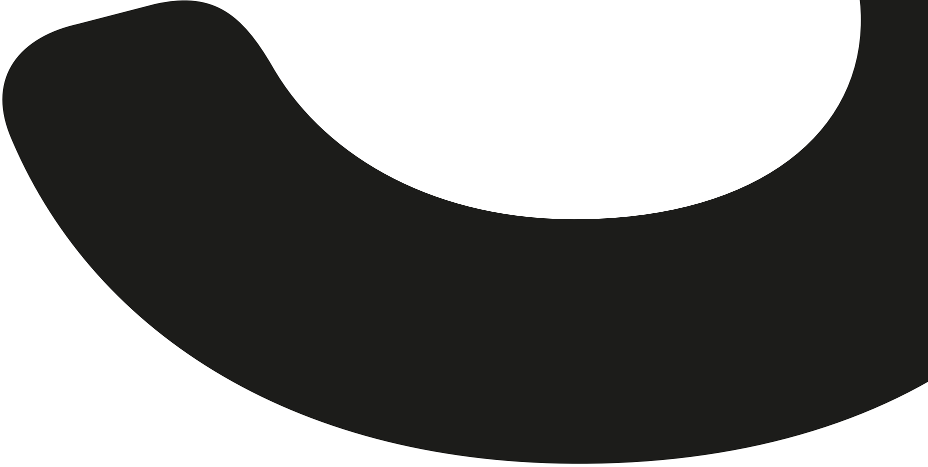
fr

O

A

p

C



T

st

it

SU

lit

T

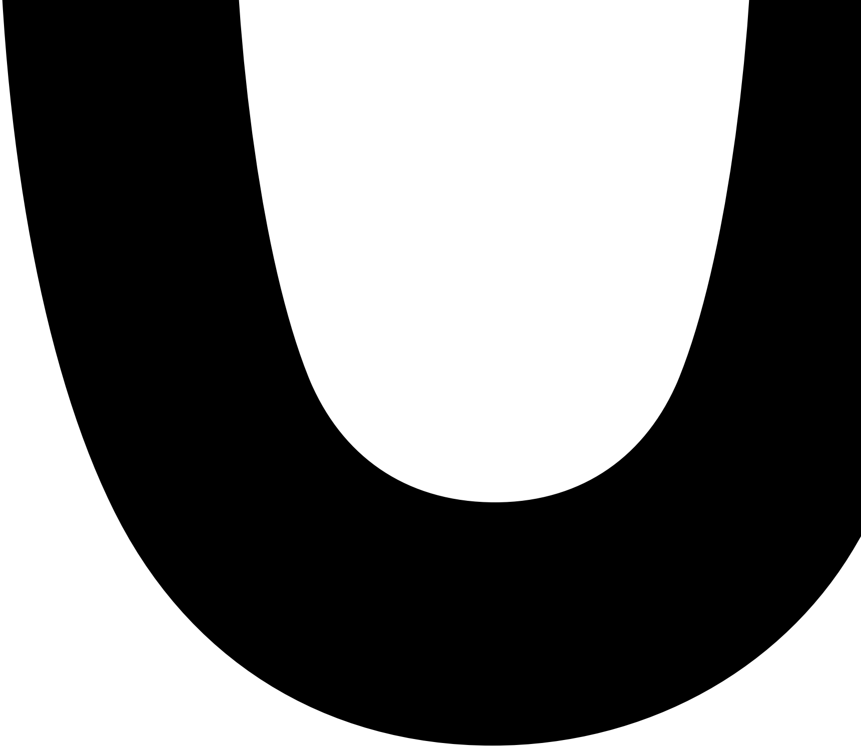
sp

th

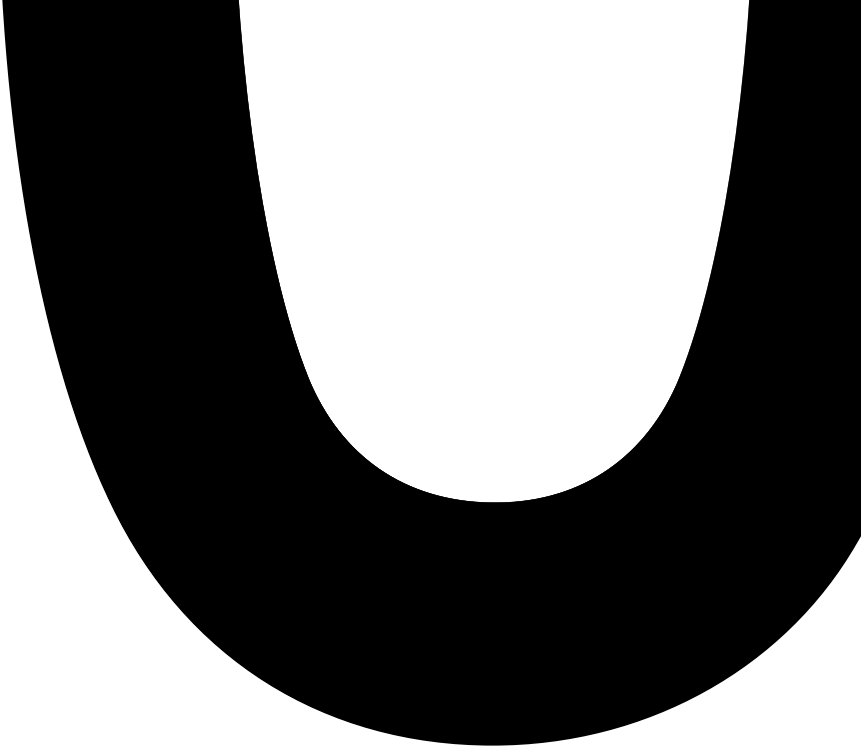
Plant fact

It takes two or
years for mothe
thousands to re
size and produ
plants. The pup
off and take ro
ground, scatte
their parent. W
grow up, they r
the cycle.

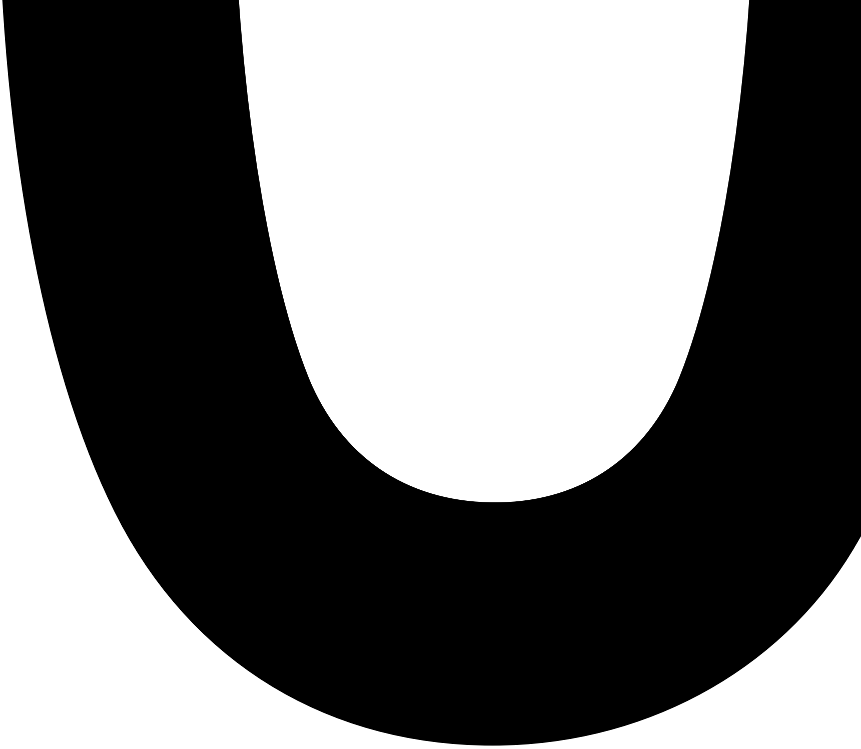
IV



[redacted]



[redacted]



U

lt

ye

th

Si

p

O

g

th

g

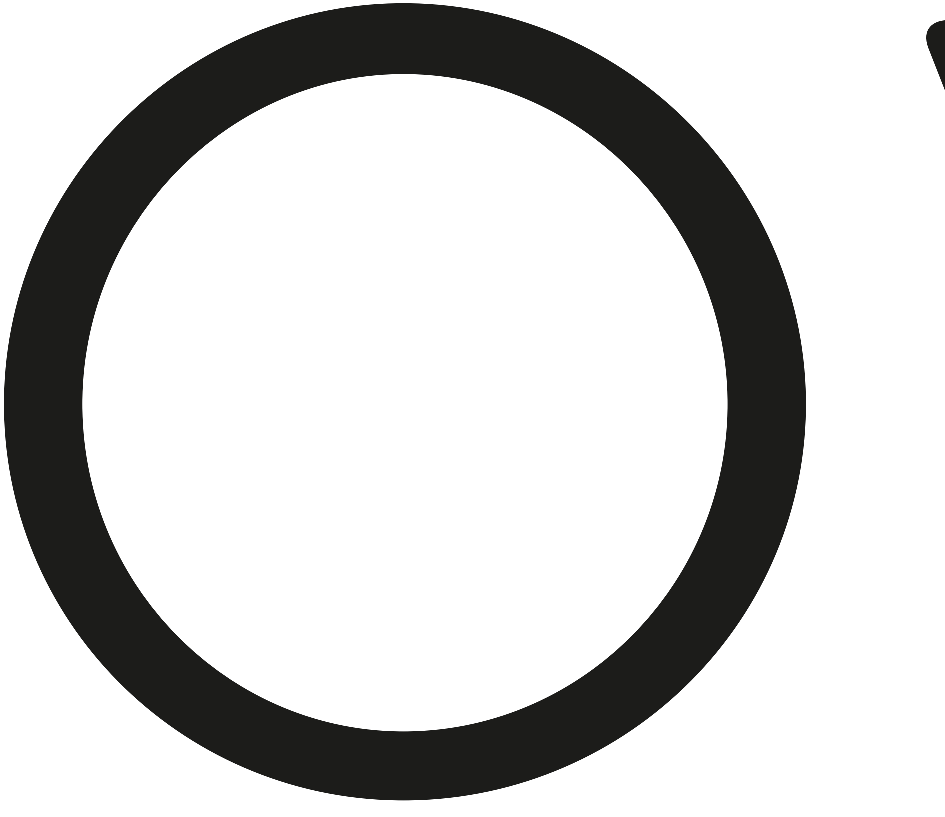
th

P

P

N

T



t

th

th

E

ro

a

p

le

S

T

up

W

th

T

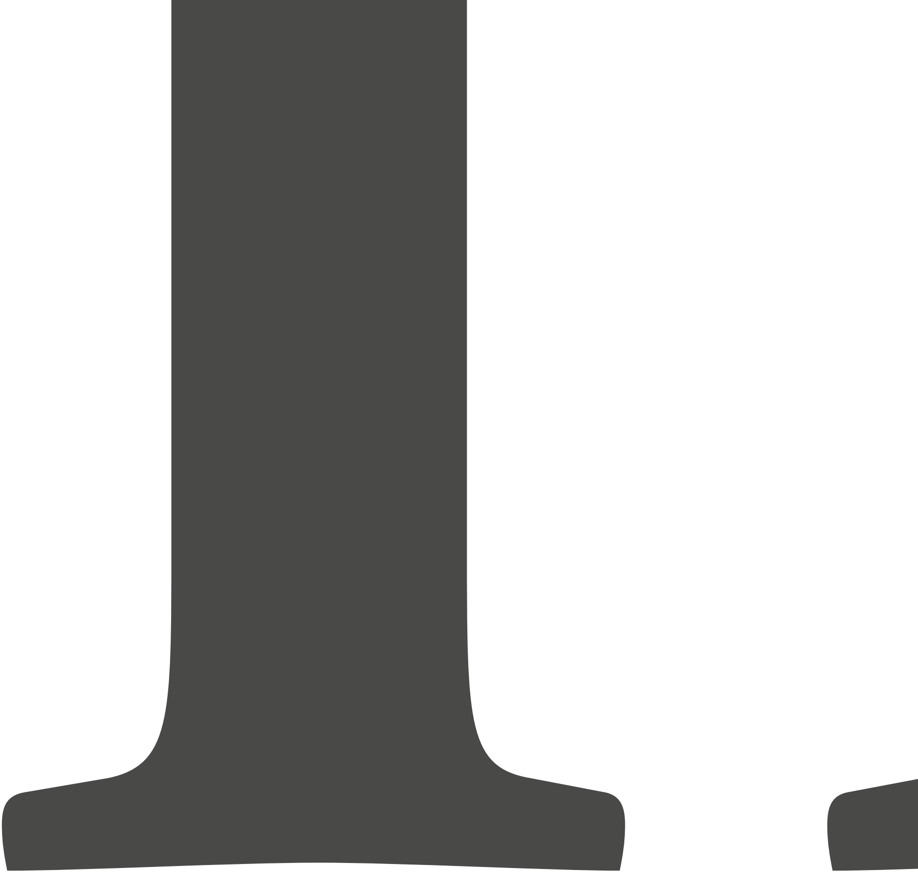
h

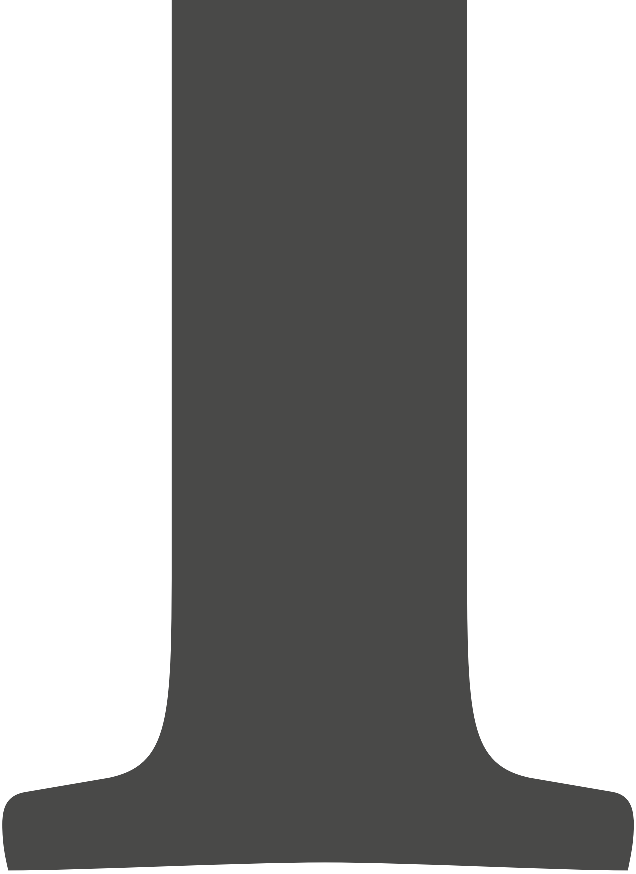
p

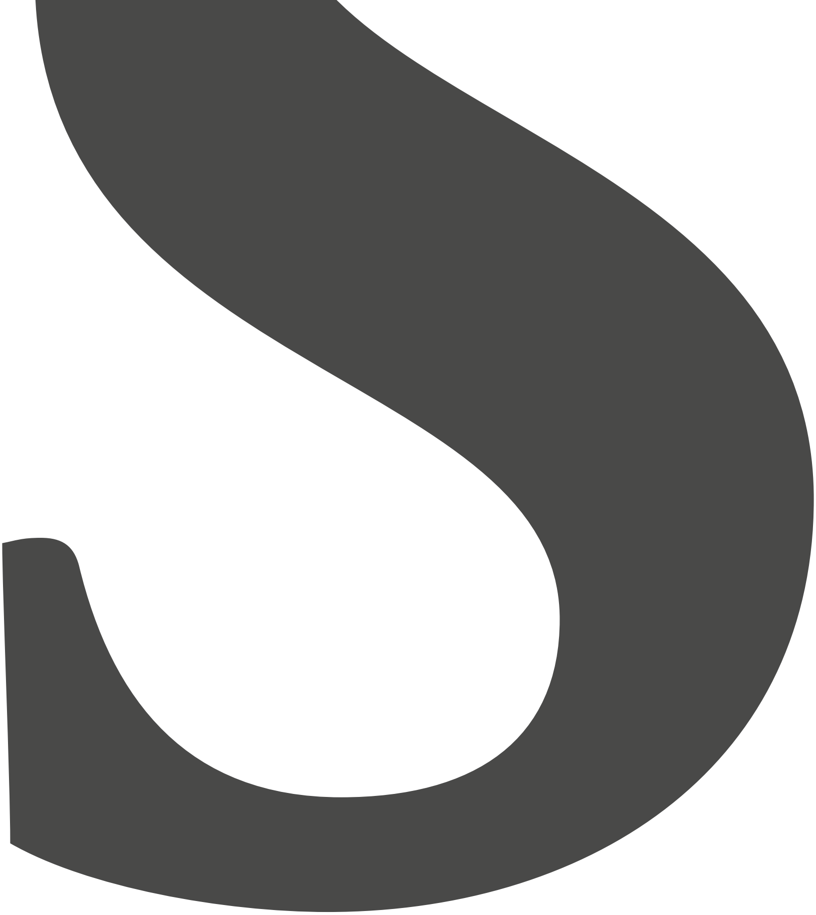
fi

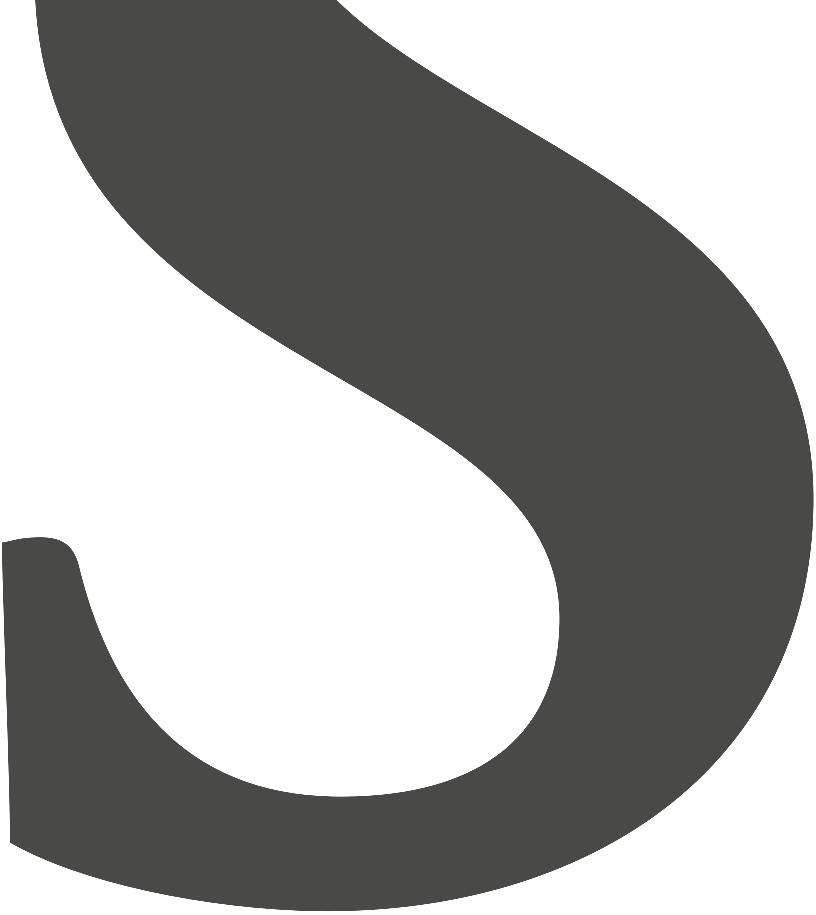
is

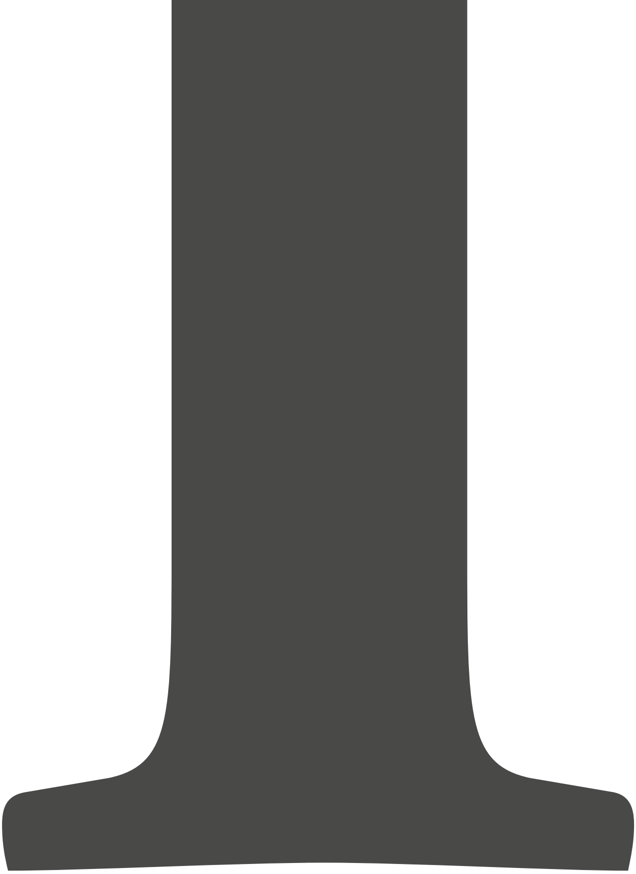
ti

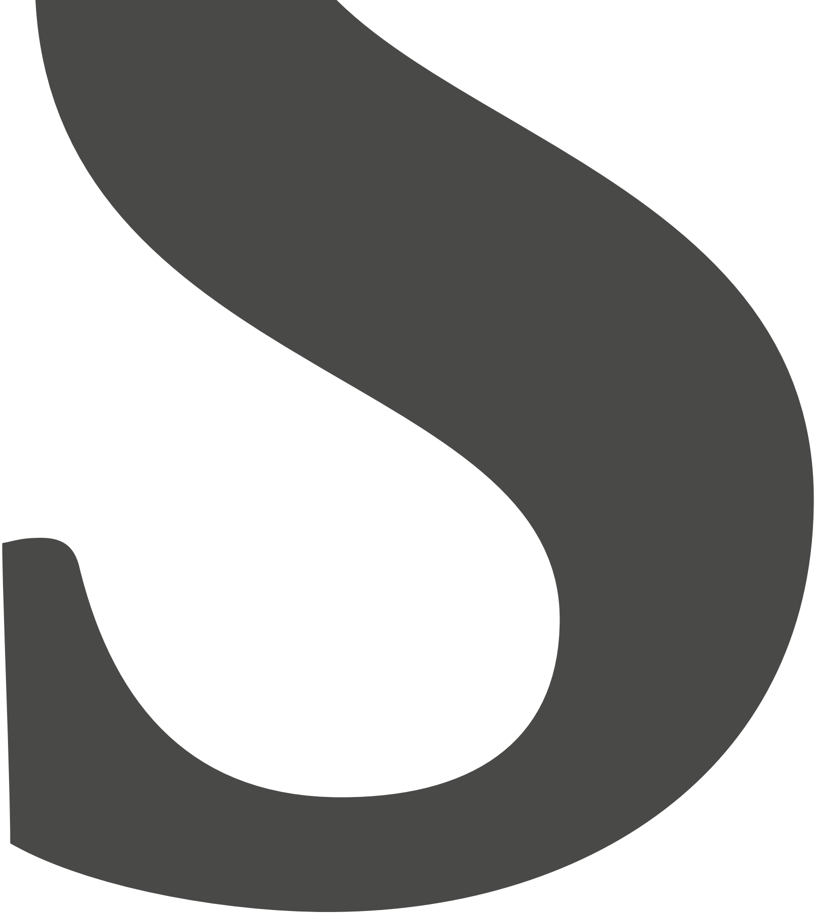


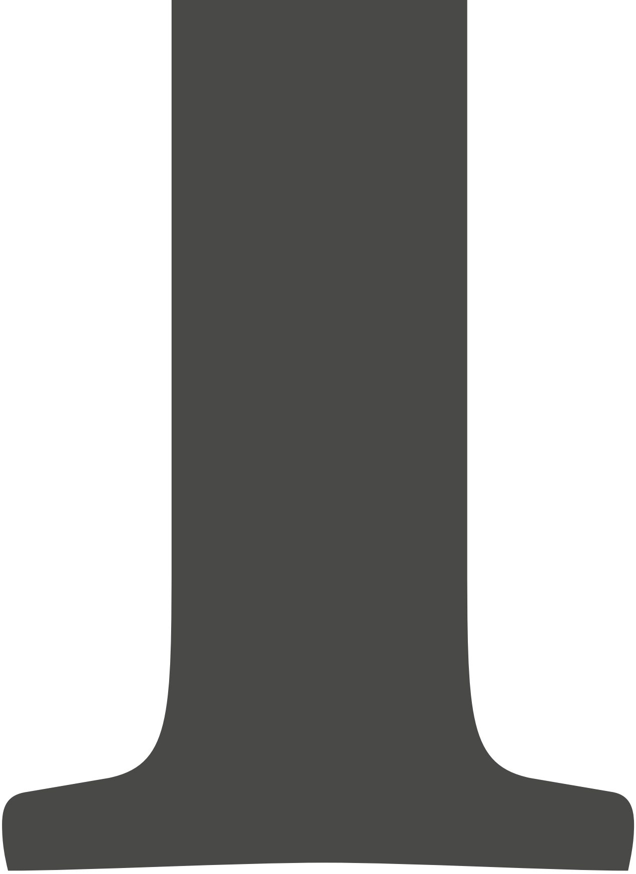


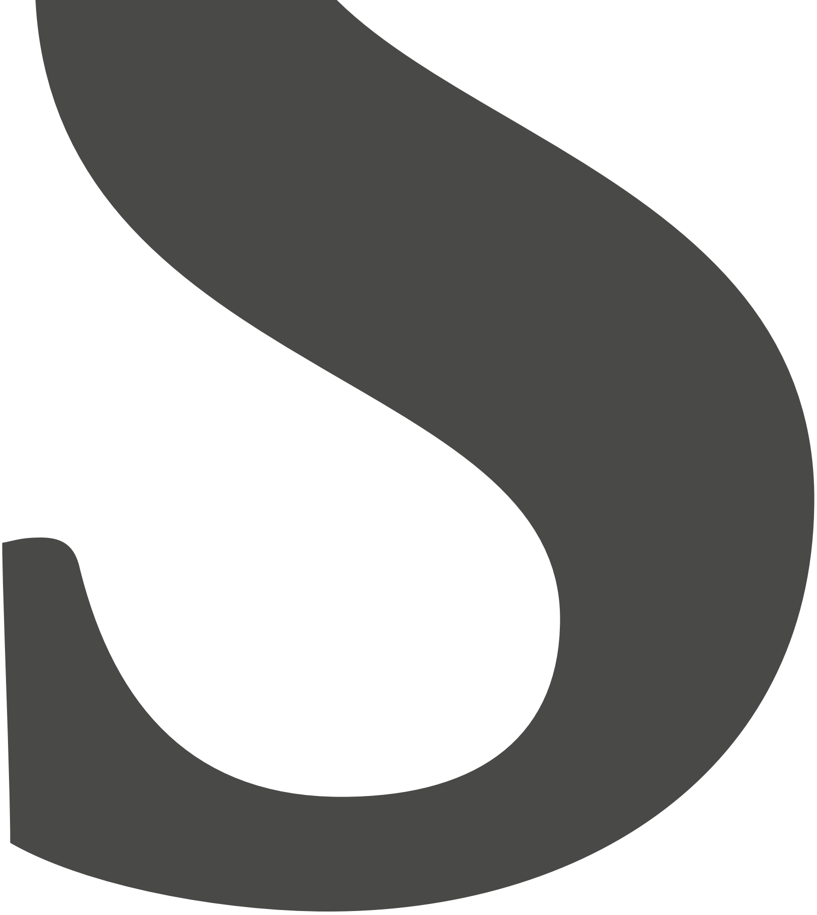


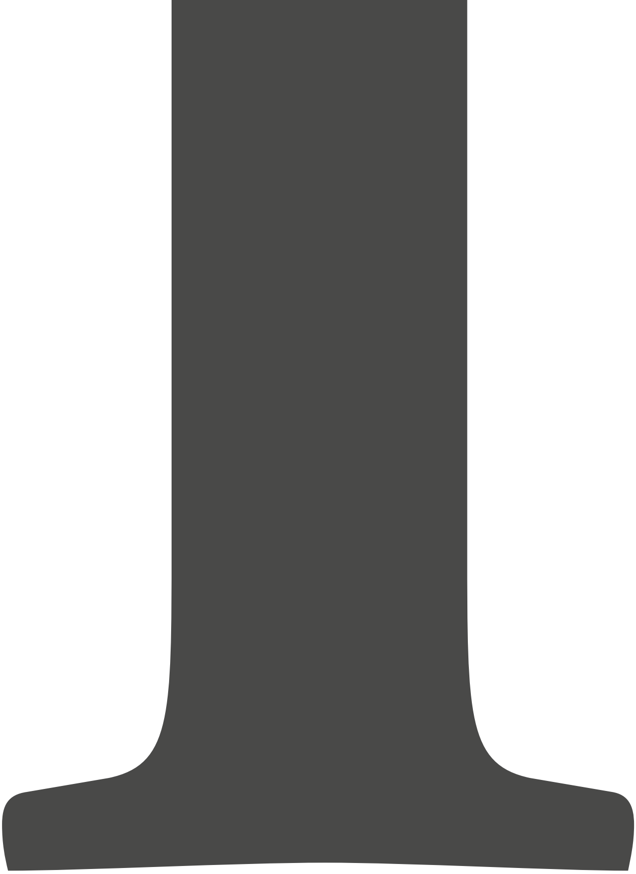


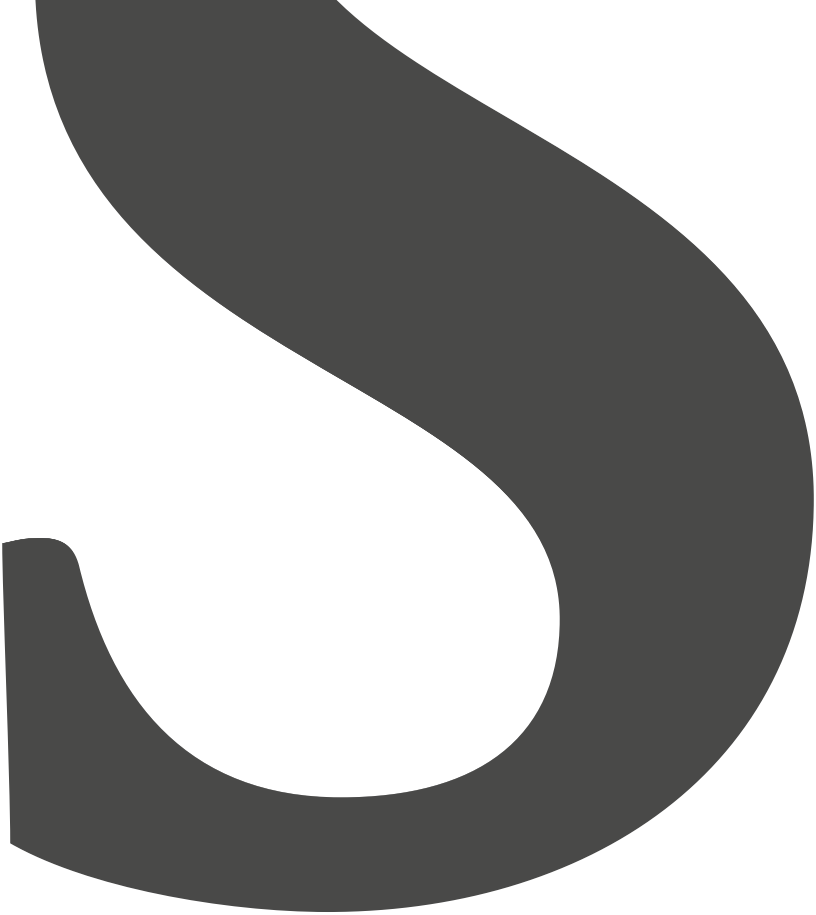


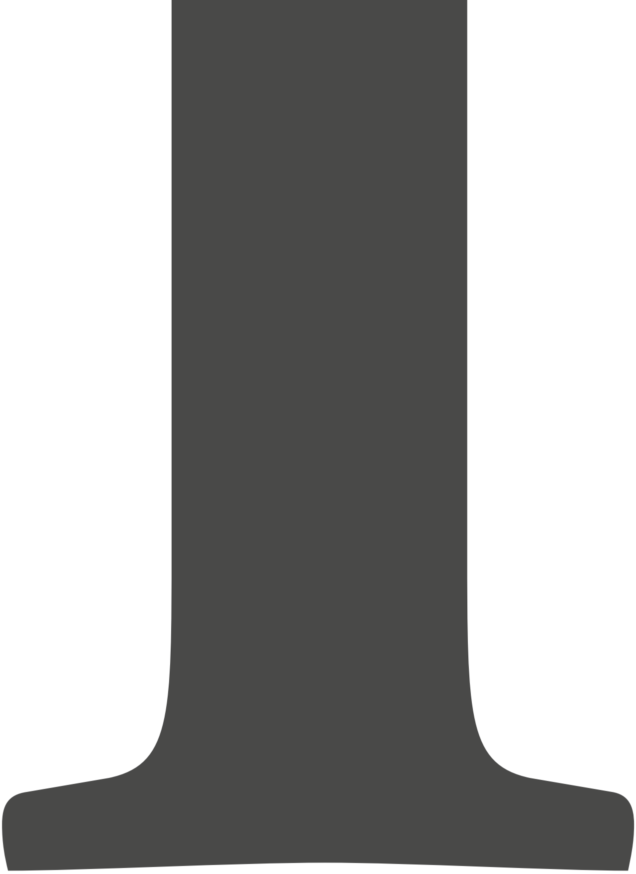


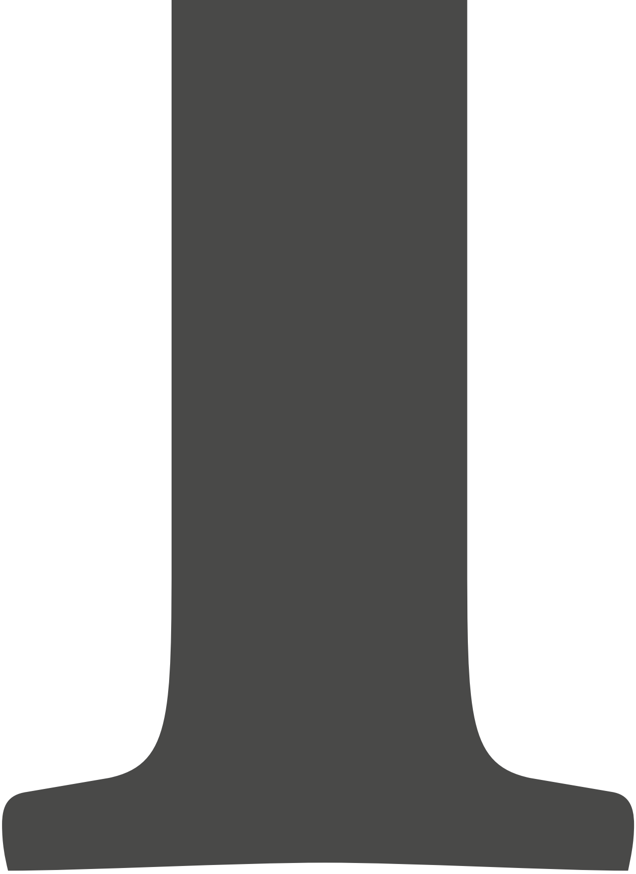


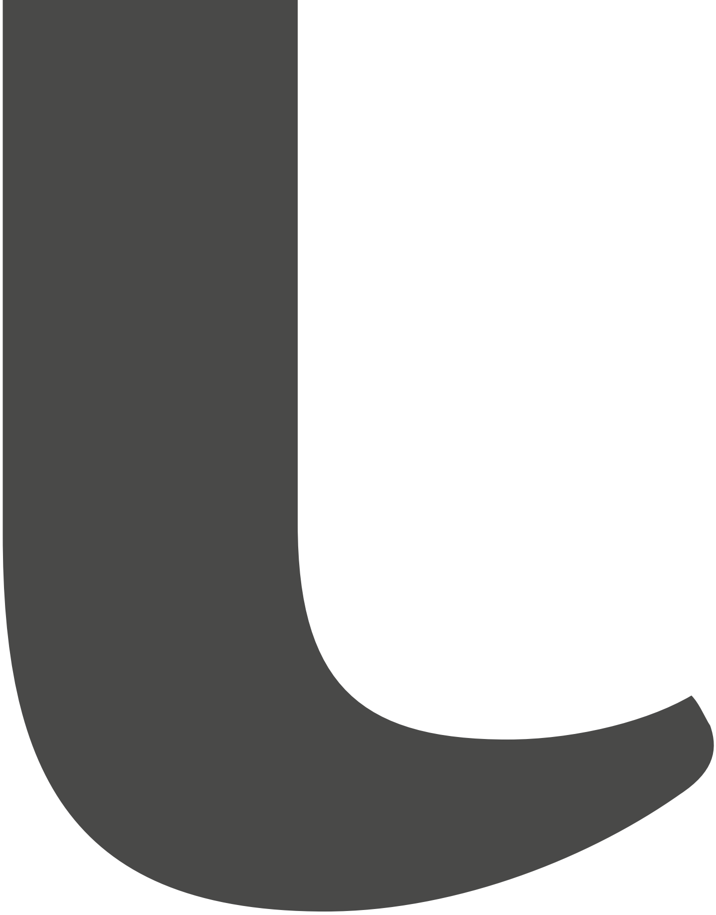


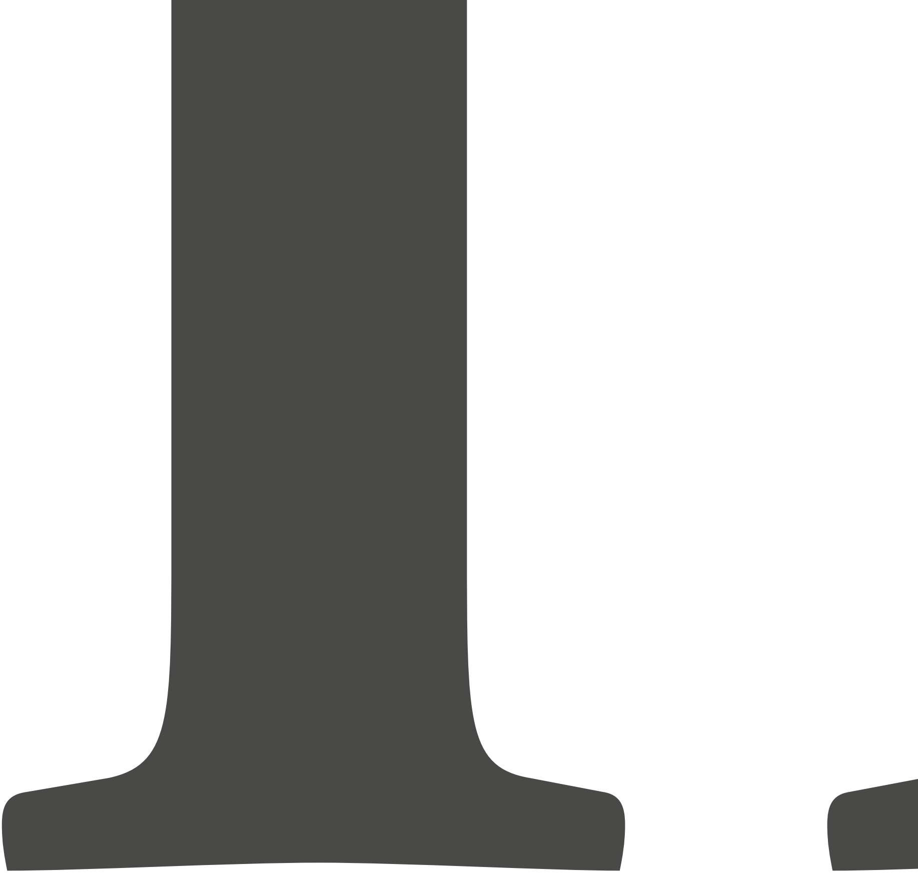


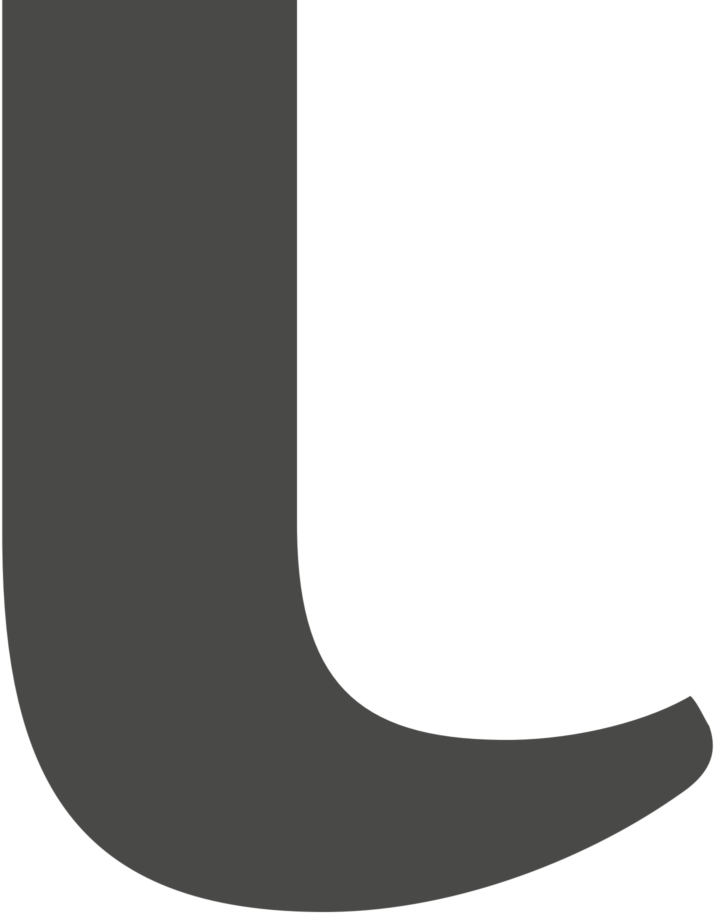


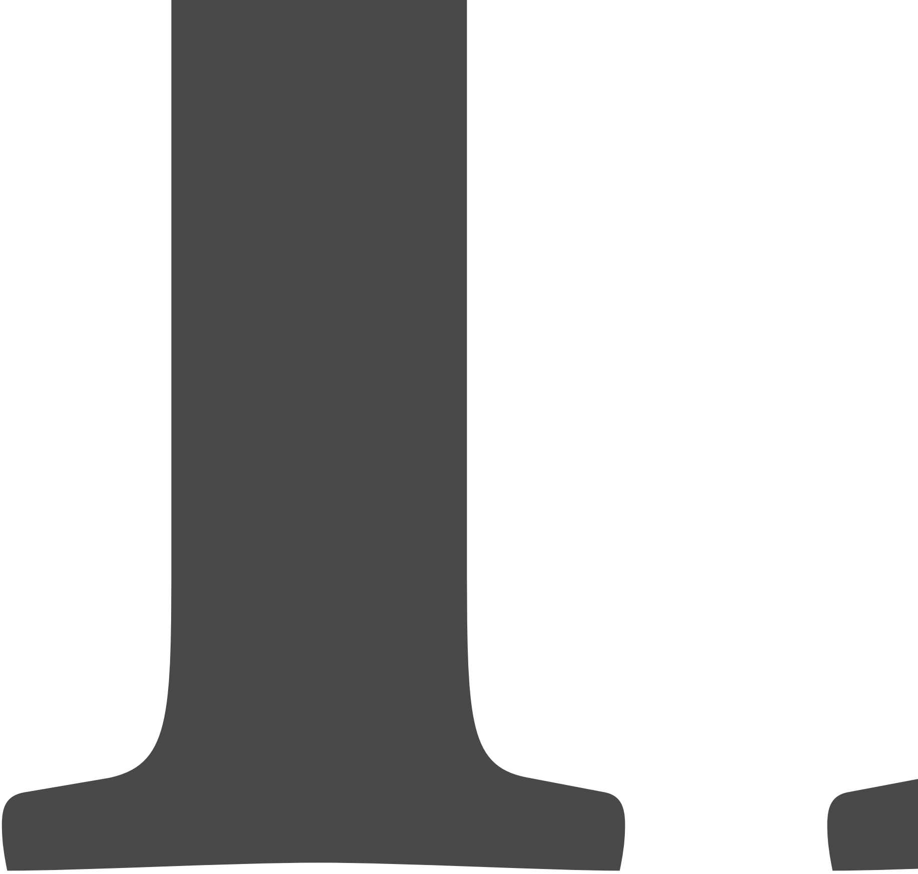


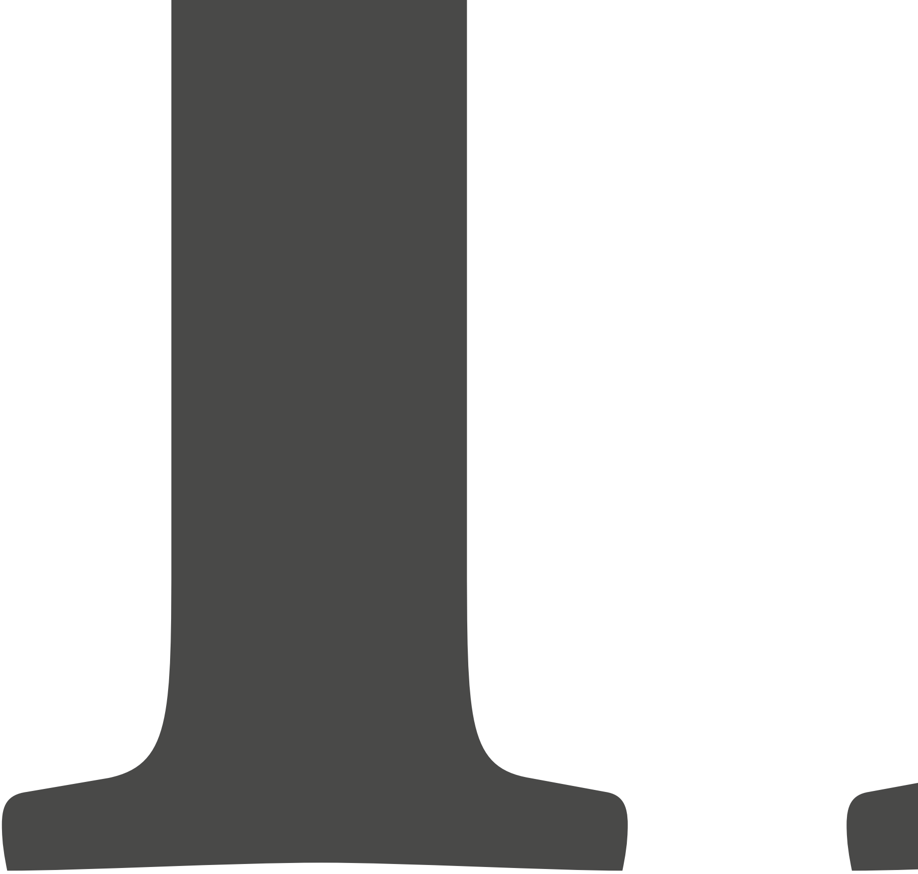


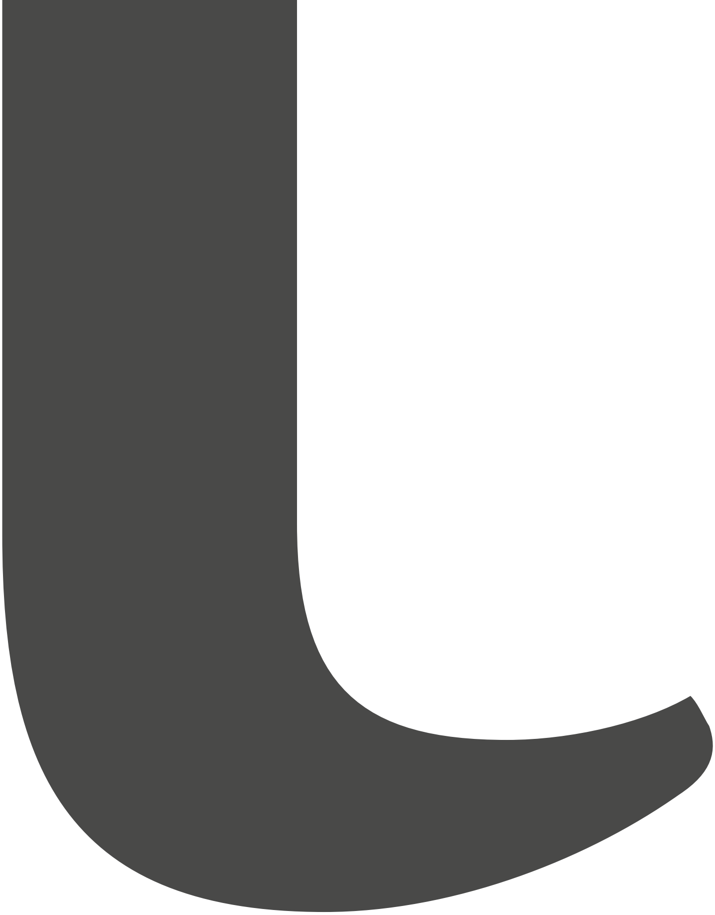


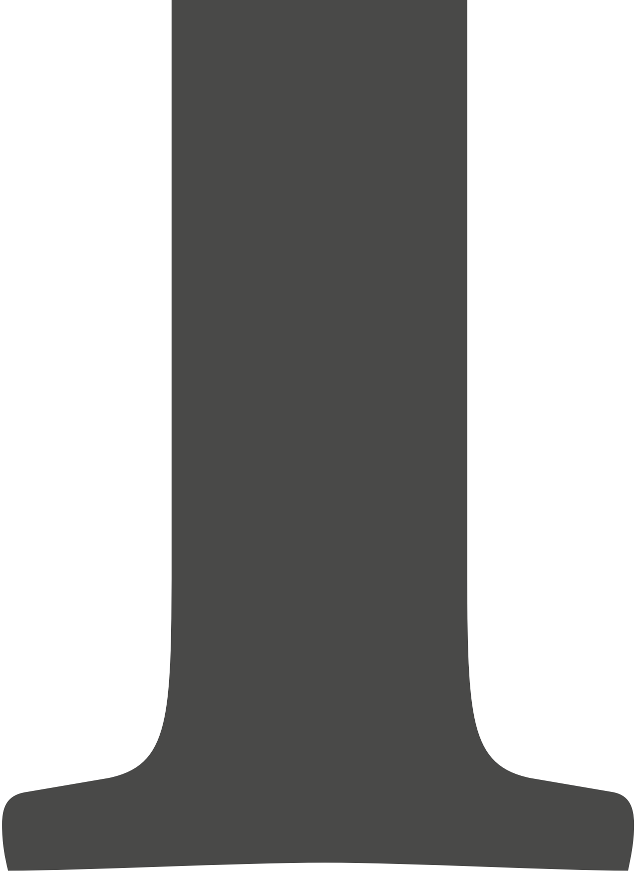




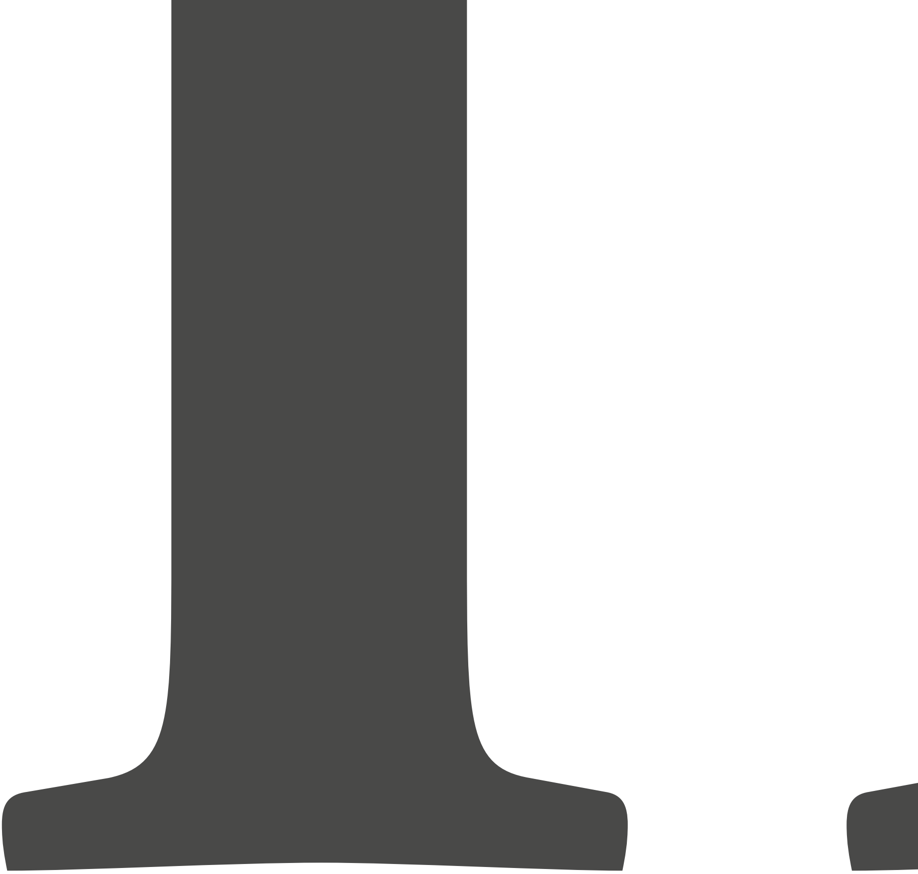


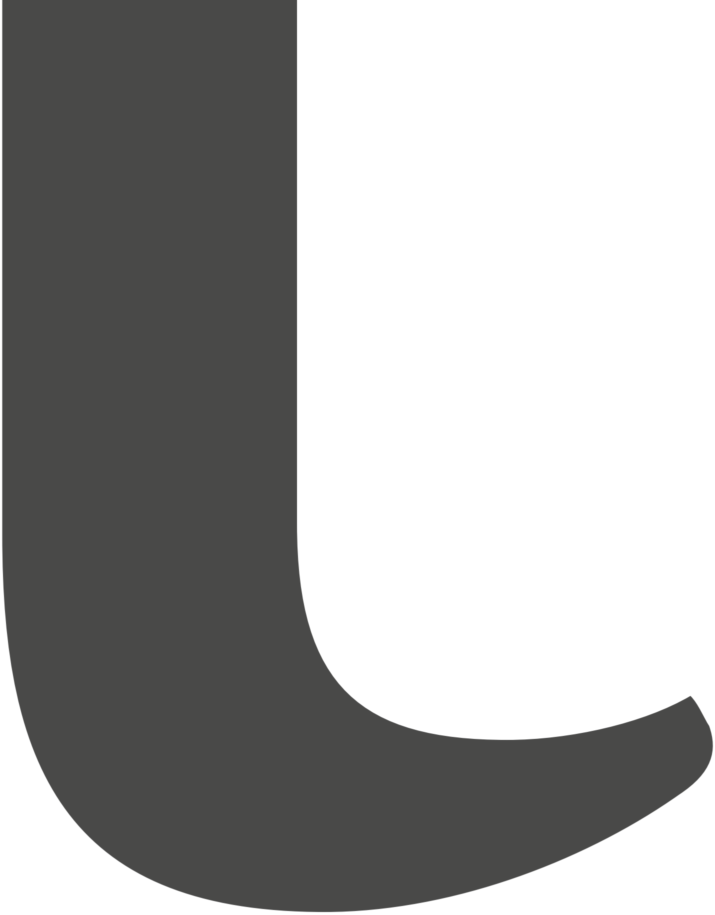


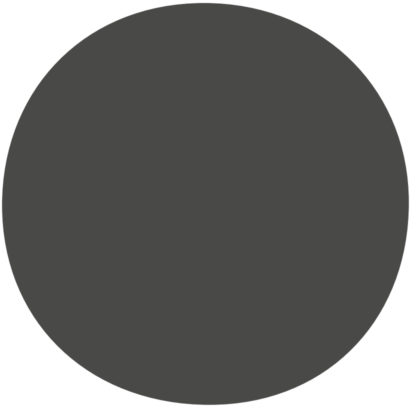




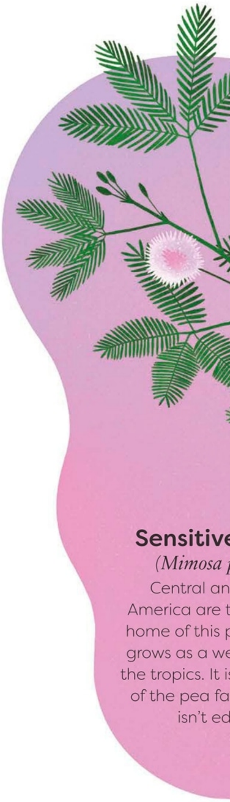
a



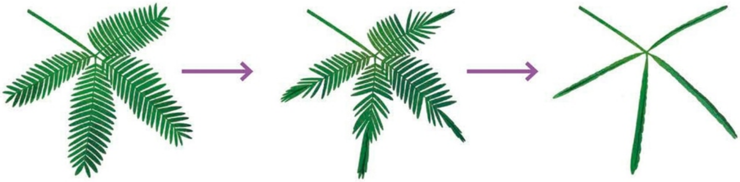




Sensitive plant



Sensitive
(Mimosa p
Central an
America are t
home of this p
grows as a we
the tropics. It i
of the pea fa
isn't ed



Closing leaves
When the sensitive plant closes its leaves, the action moves rapidly along each stem. First one leaflet closes, then its neighbor follows, and the one after that, until the entire leaf is shut. It looks like a line of dominoes toppling over.

[redacted]

[redacted]

V

[redacted]

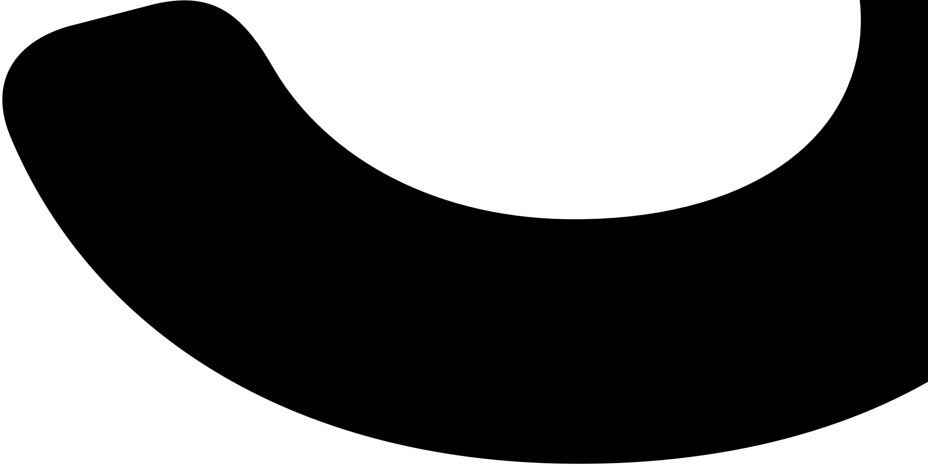
[redacted]

W

ro

n

is



C

A

h

g

th

O

is

L

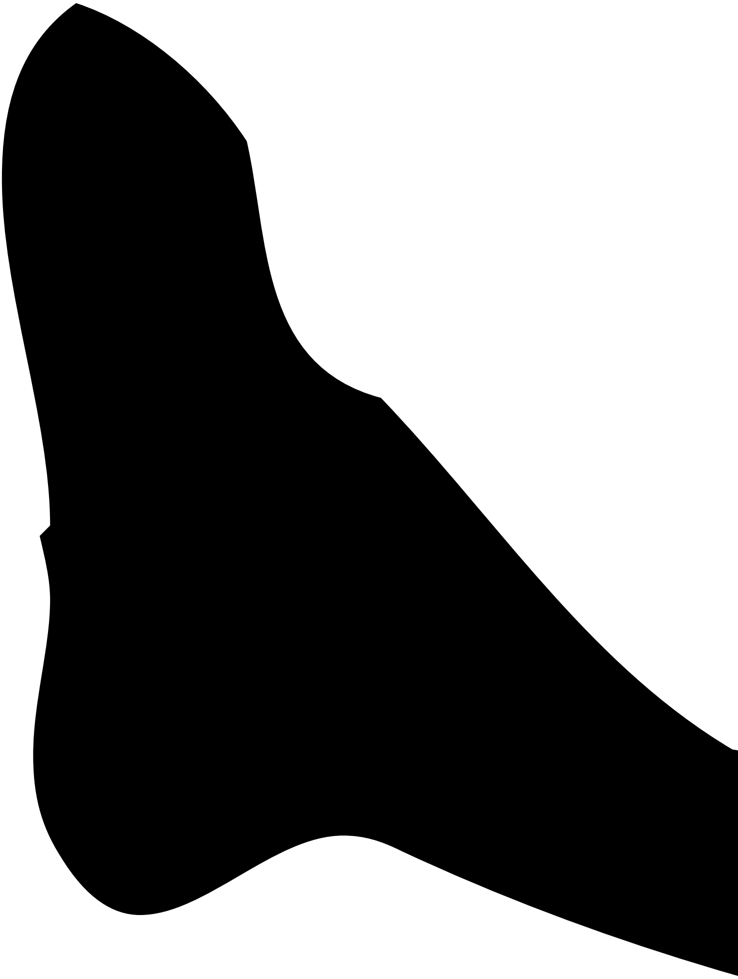
o

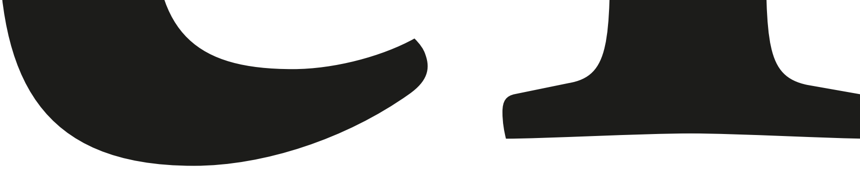
L

t

L

c





Plants that move

D

d

a

st

p

T

st

th

a

th

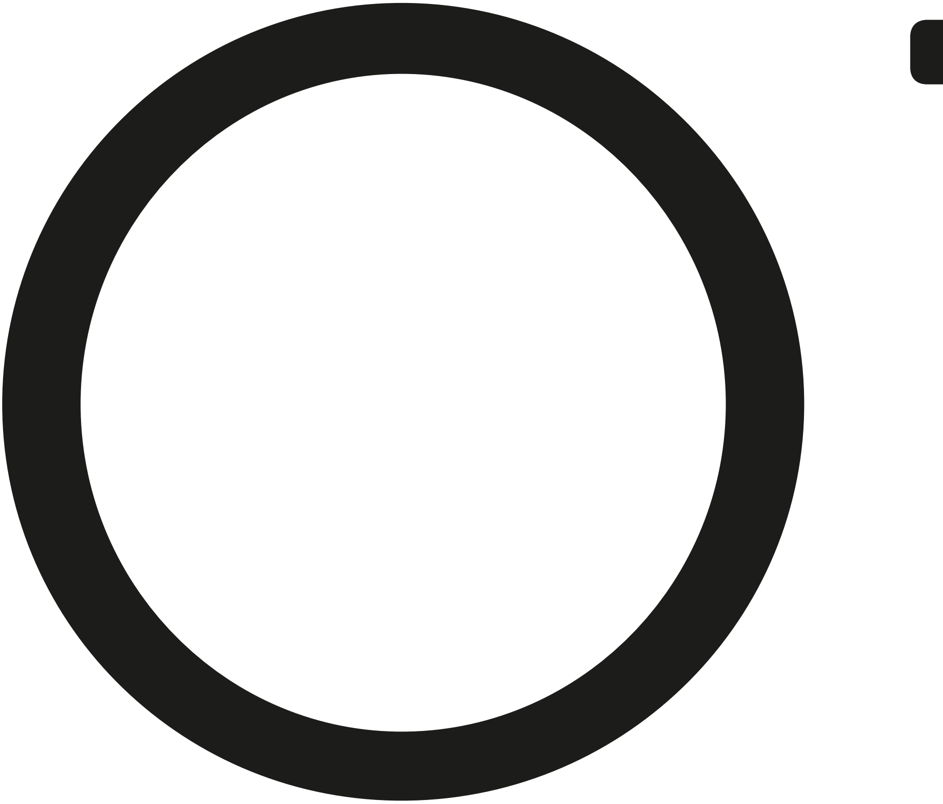
A

“

S

f

Sl



E

le

u

b

W

tr

T

e

W

d

fr

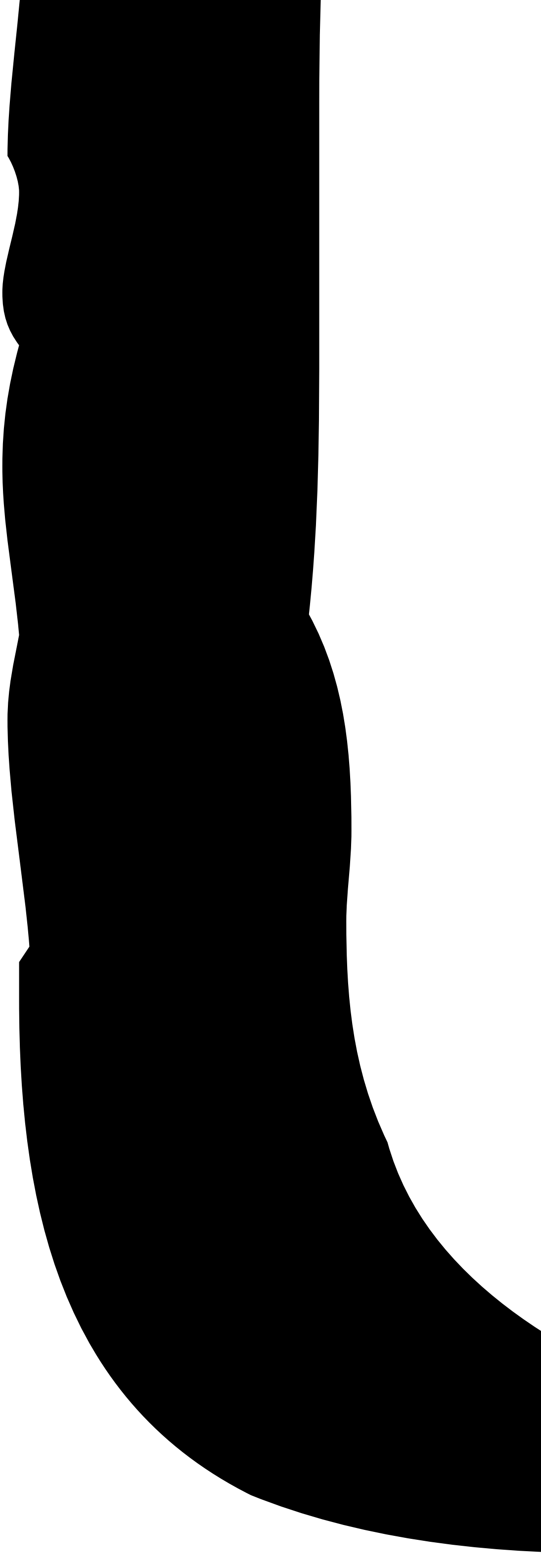
W

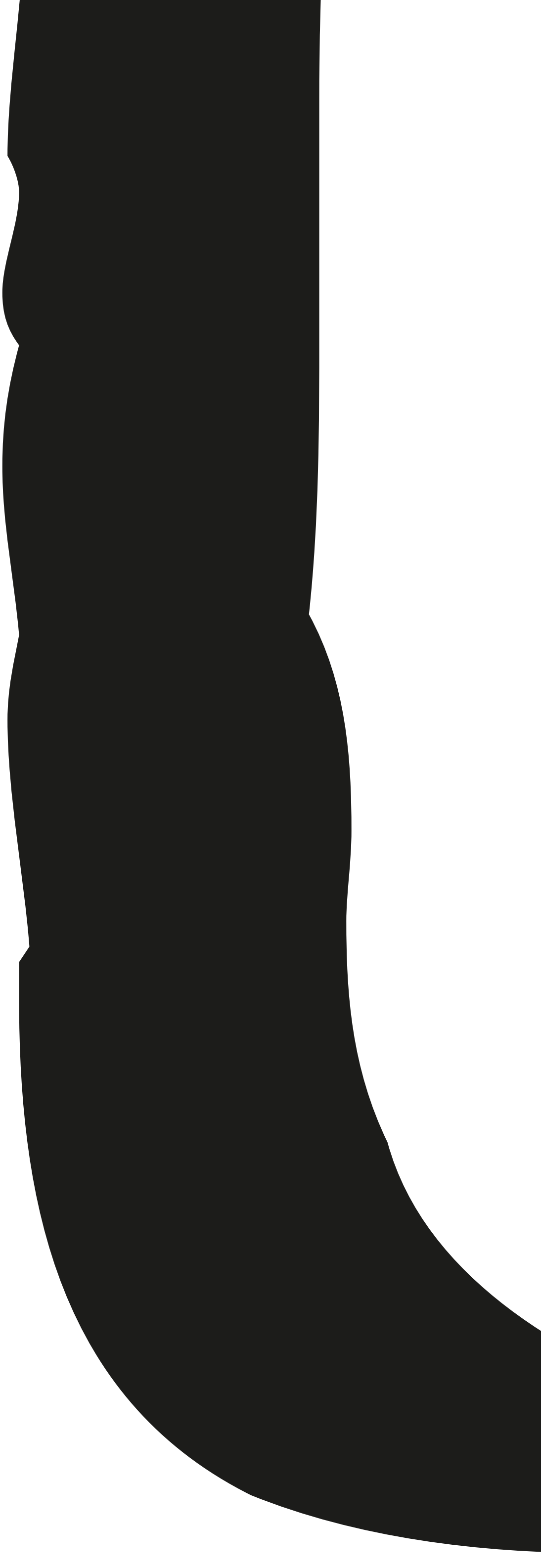
a

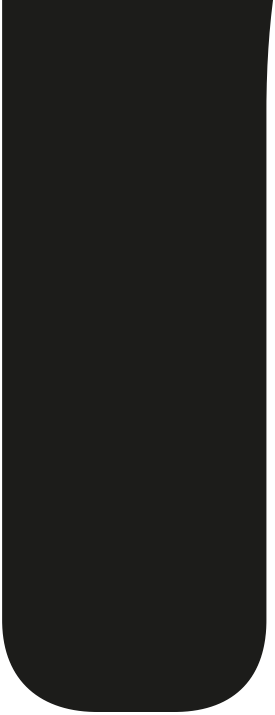
e

th

it

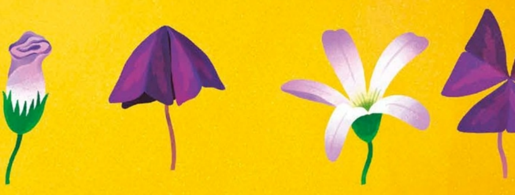






Plant body clocks

All plants, like animals, have a kind of internal clock. This allows them to do things at the right time of day or night. For example, they might open or close their flowers and leaves, and start or stop photosynthesis.

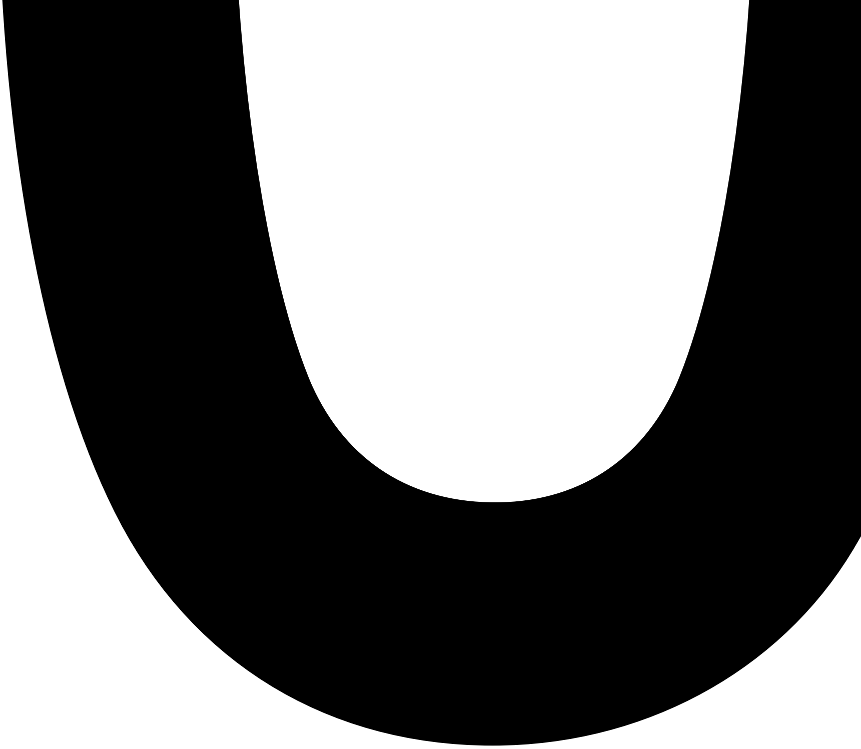


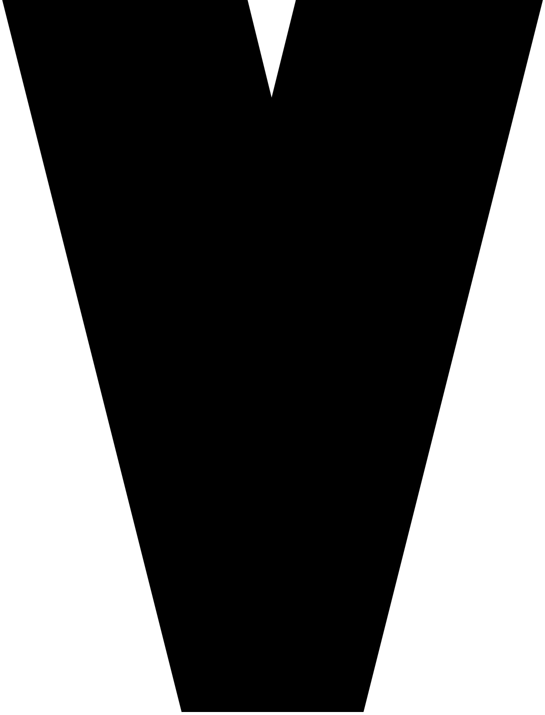
[redacted]

[redacted]

[redacted]

IV





T

th

p

le

S

S

p

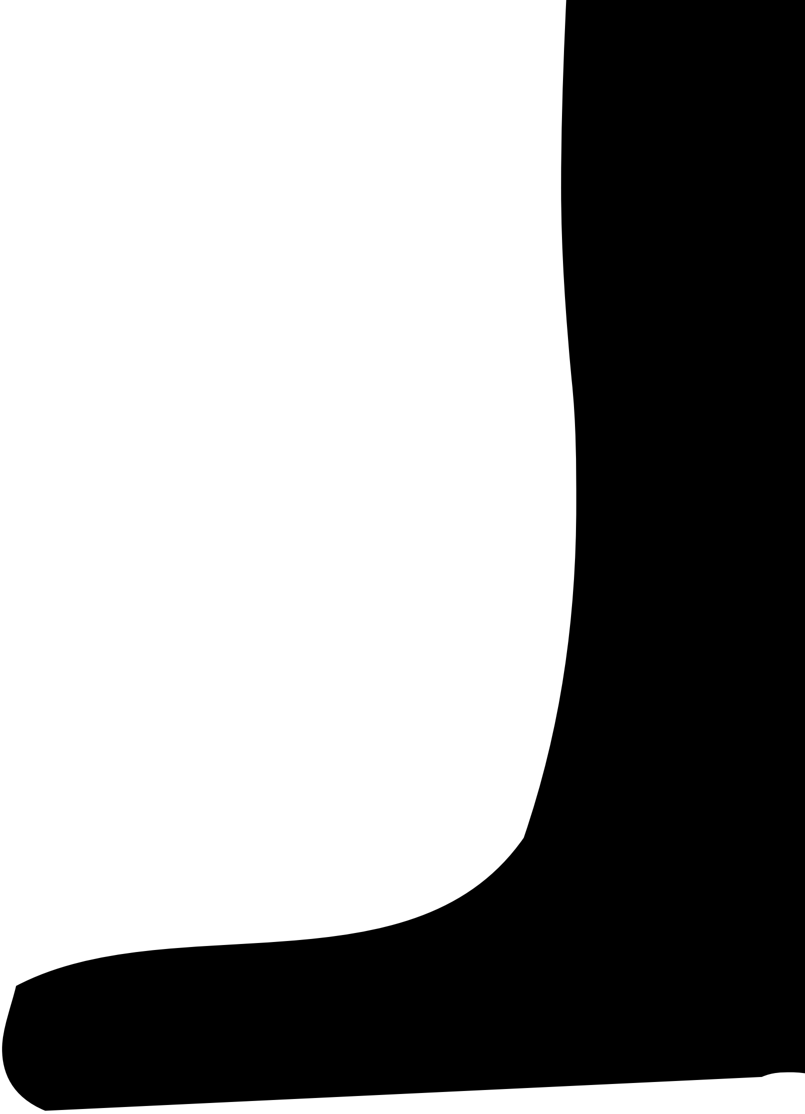
th

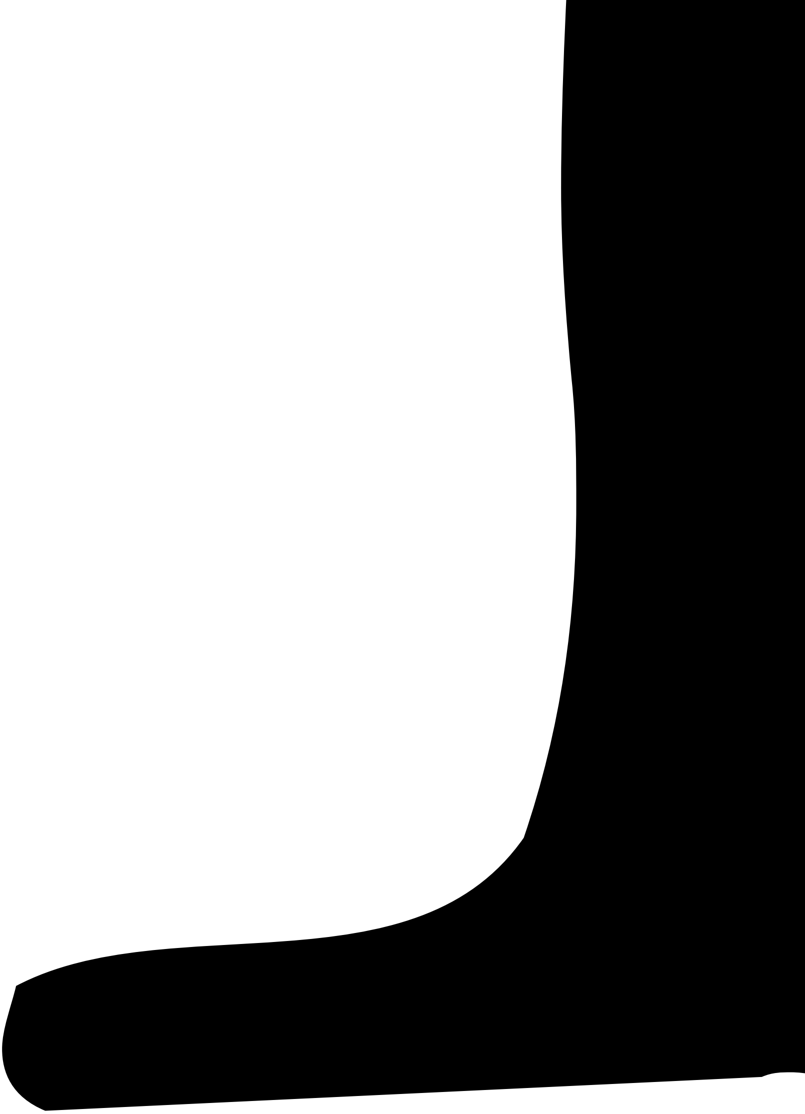
th

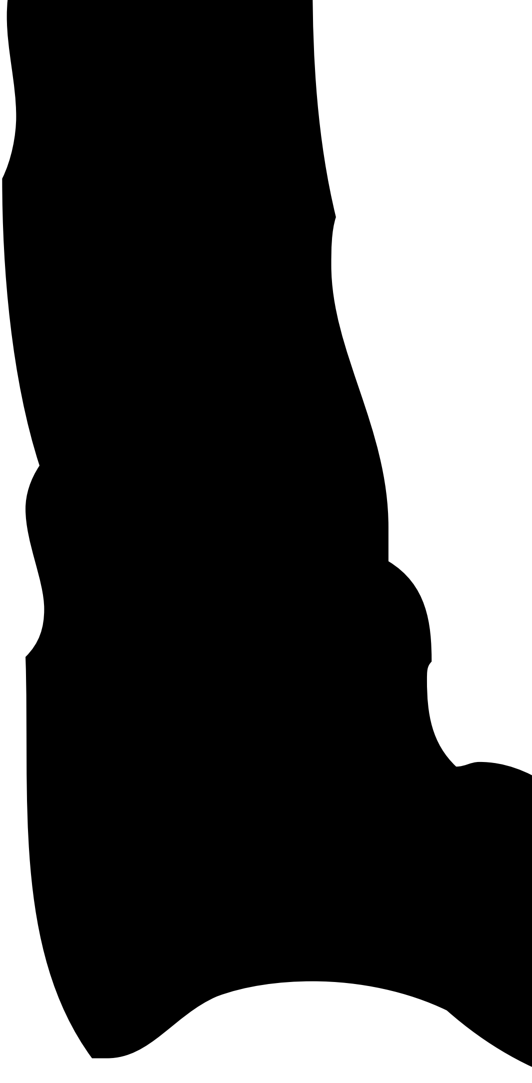
it

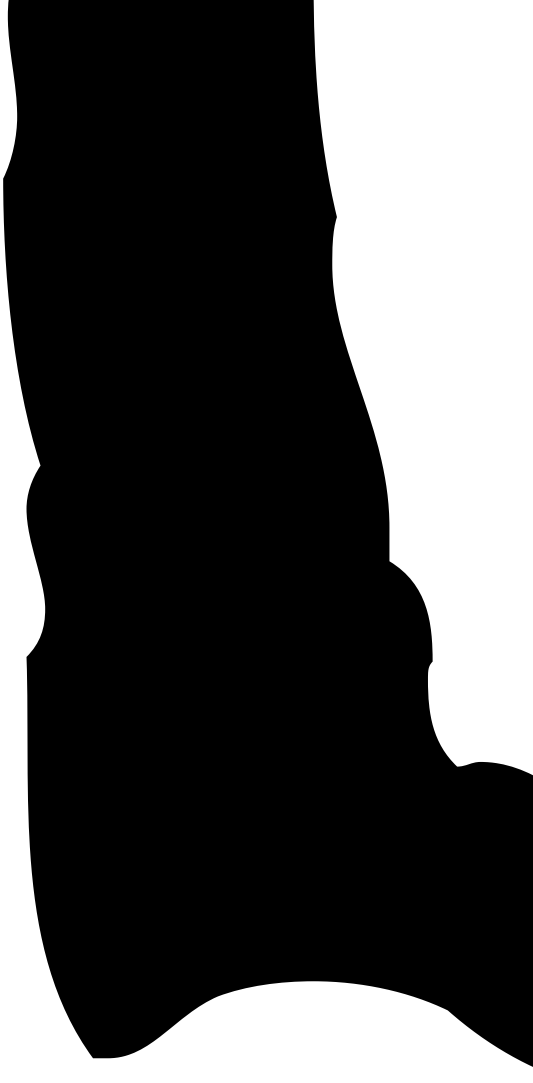
th

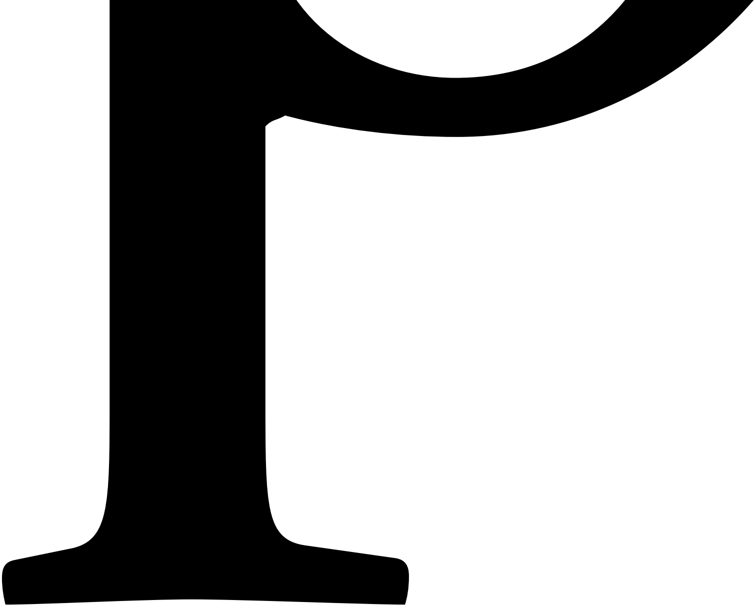
N











A

of

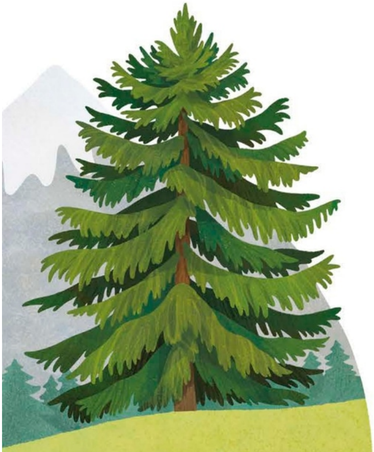
g

A

le

it

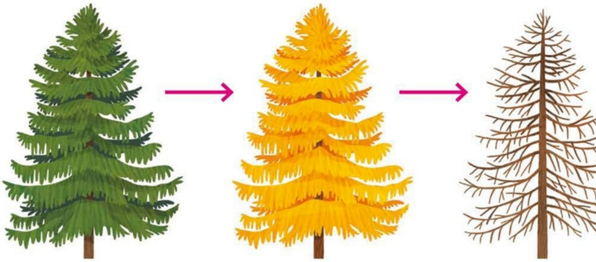
European larch



European larch
(Larix decidua)
Forests with these trees are common in Europe's mountains, and they are widely planted for their useful wood.

Through the seasons

All summer, the European larch has green needles like any other conifer. However, in fall, it turns a dazzling golden yellow, so the tree stands out against its always-green relatives. The needles drop in winter, and regrow in spring.



A

h

C

a

th

it

T

a

F

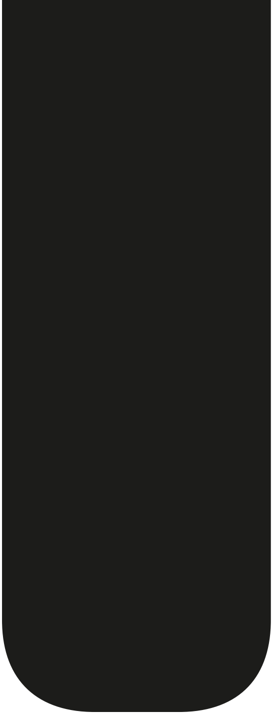
a

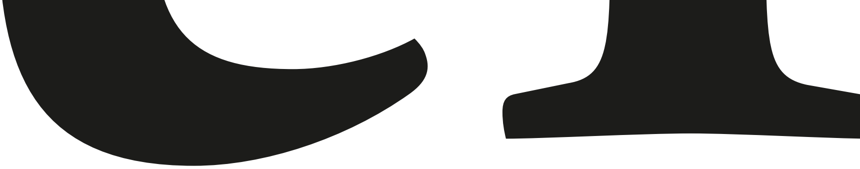
m

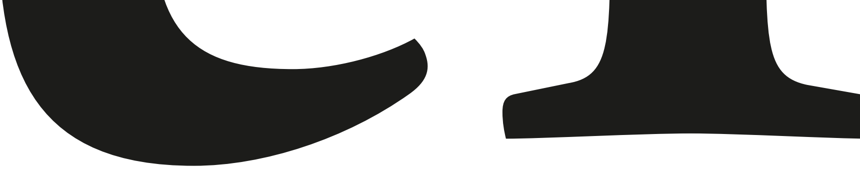
W

u

S

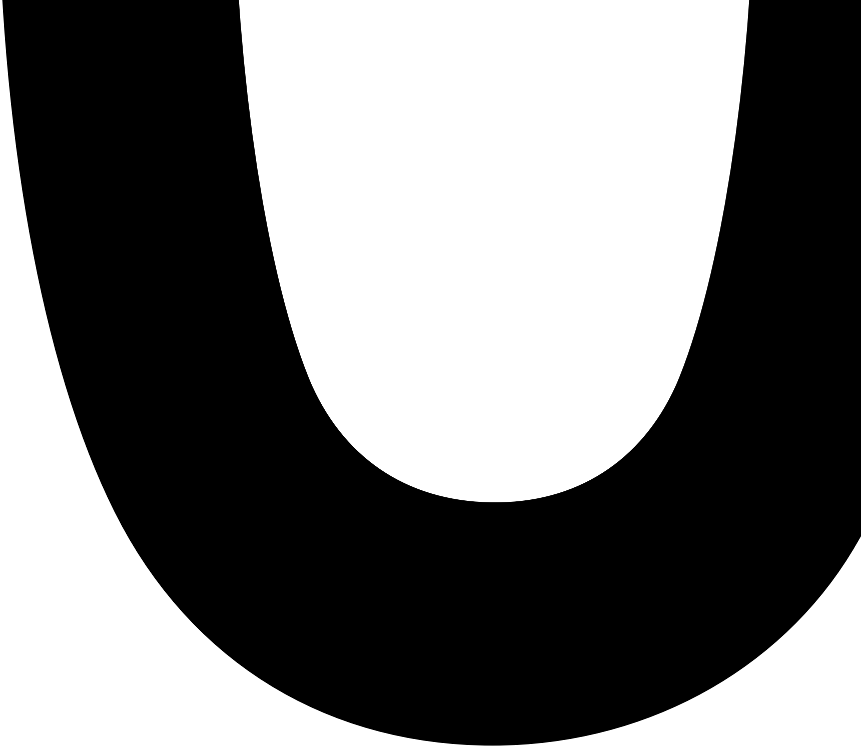




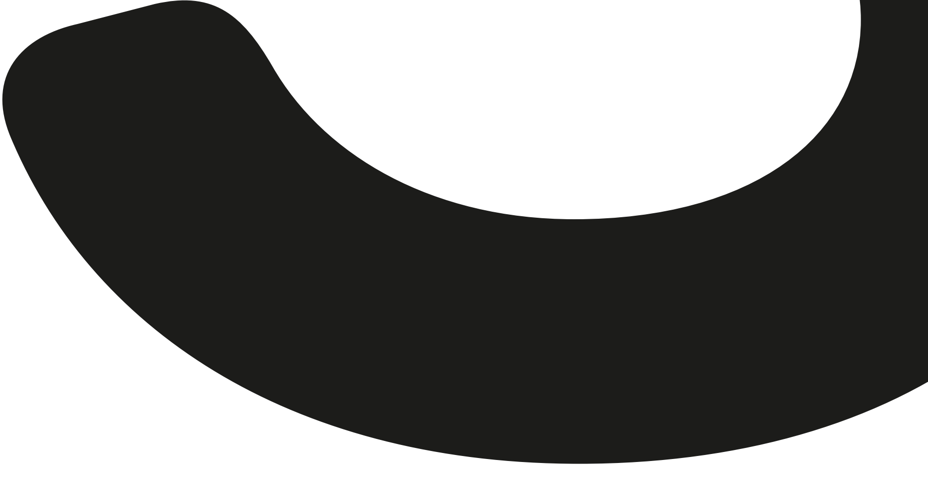


EUROPEAN

U



[redacted]



L

m

T

C

ro

h

T

th

2

L

C

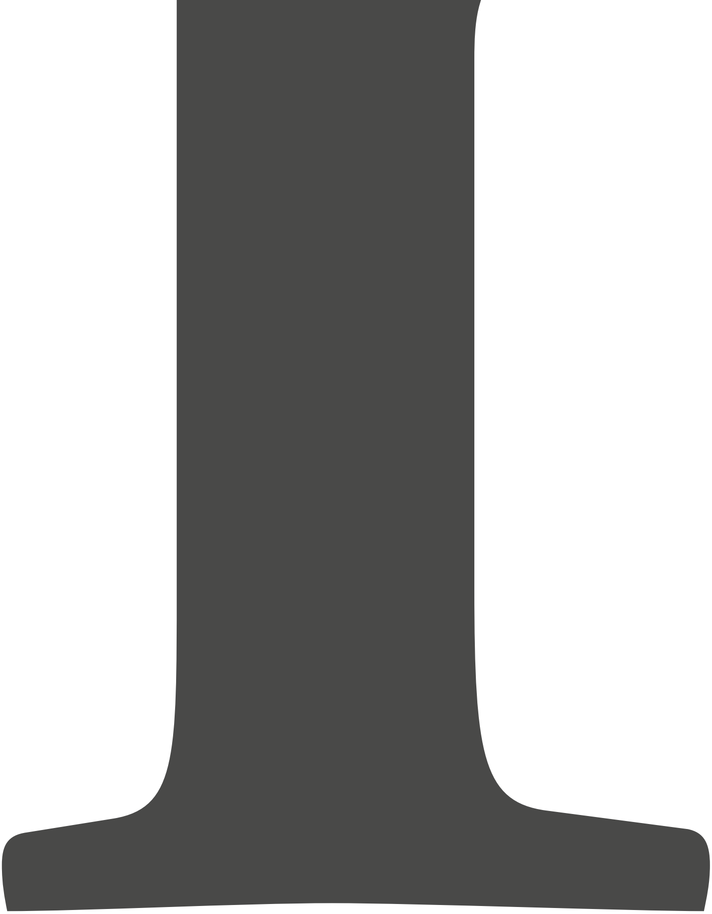
SU

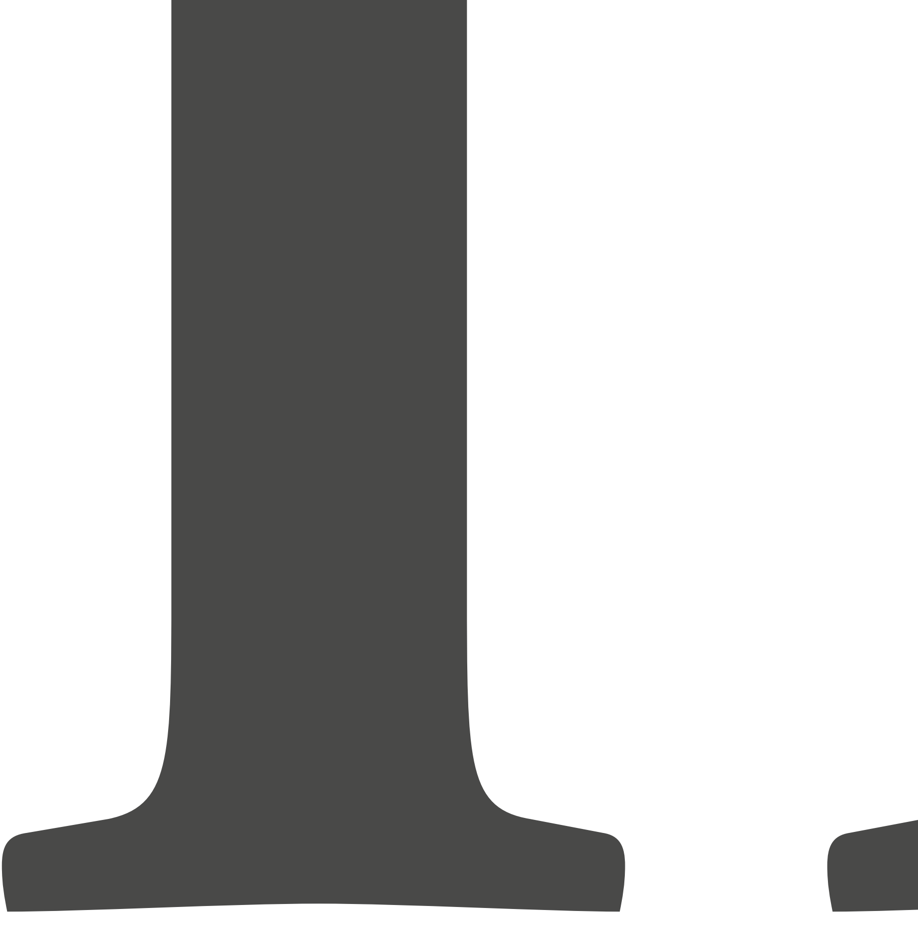
e

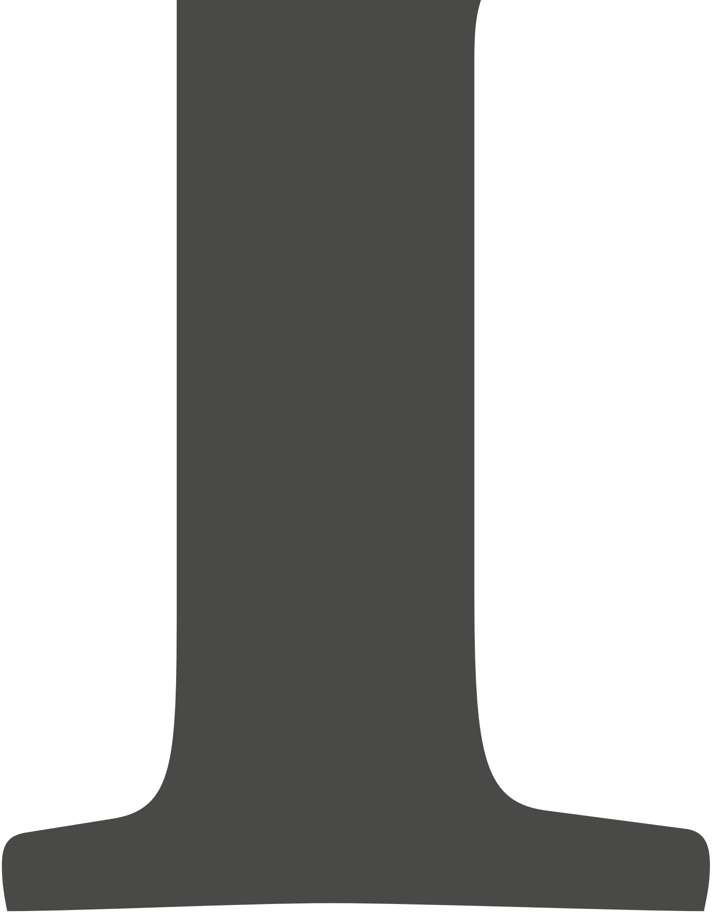
th

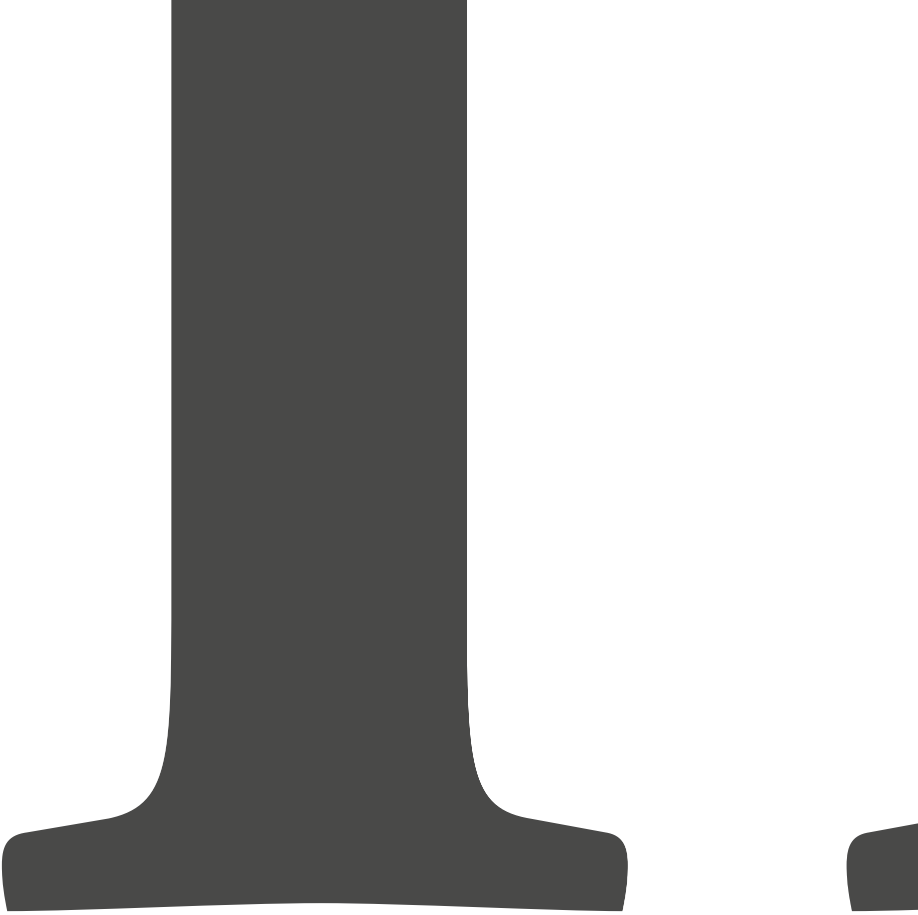
Tu

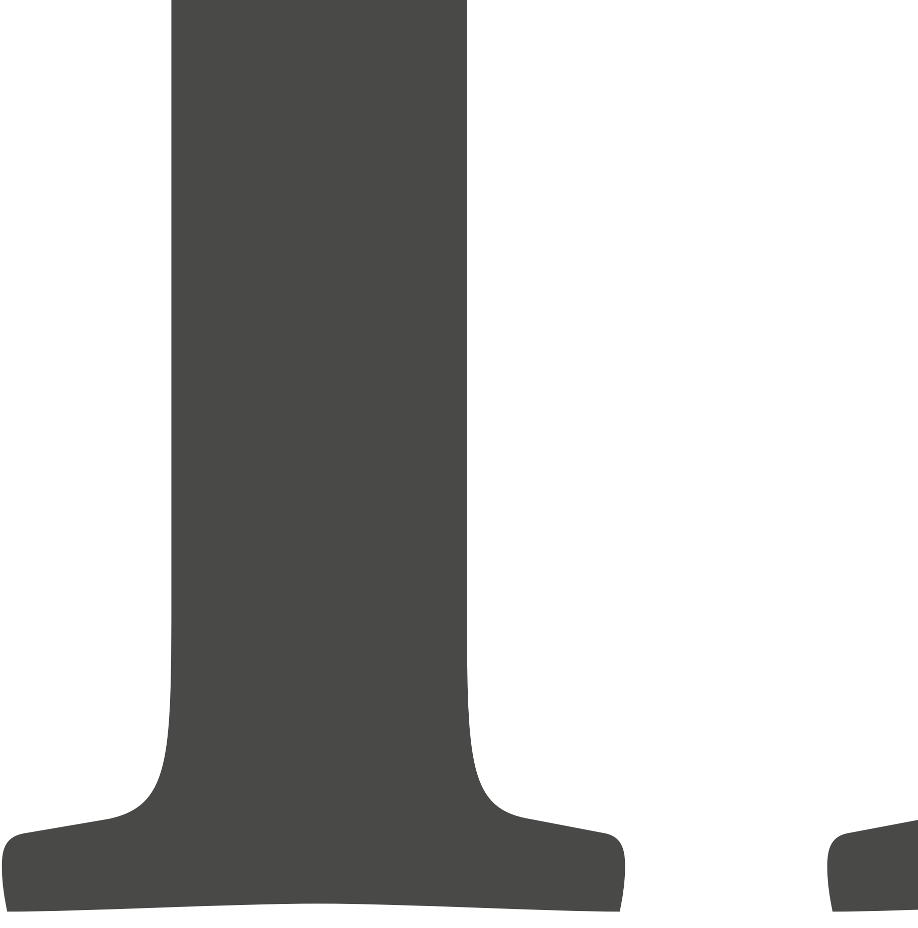
sp

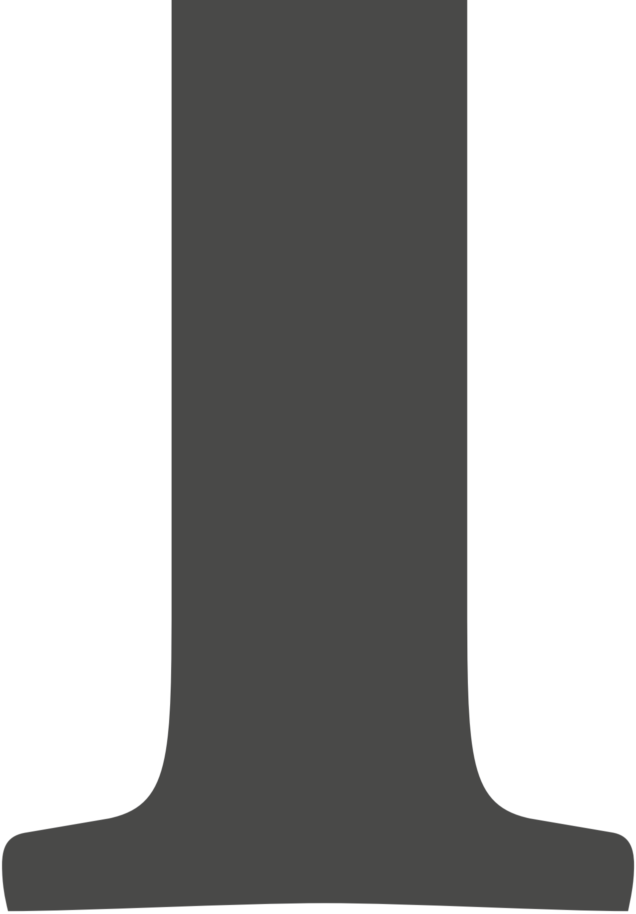


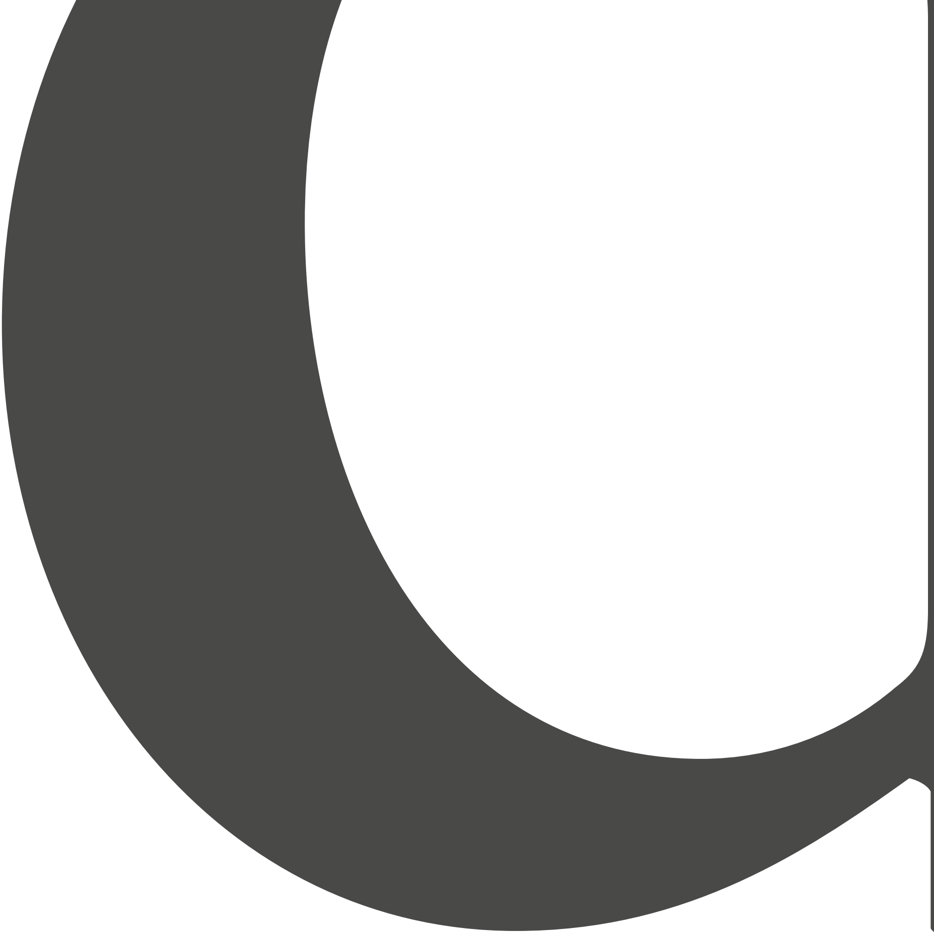




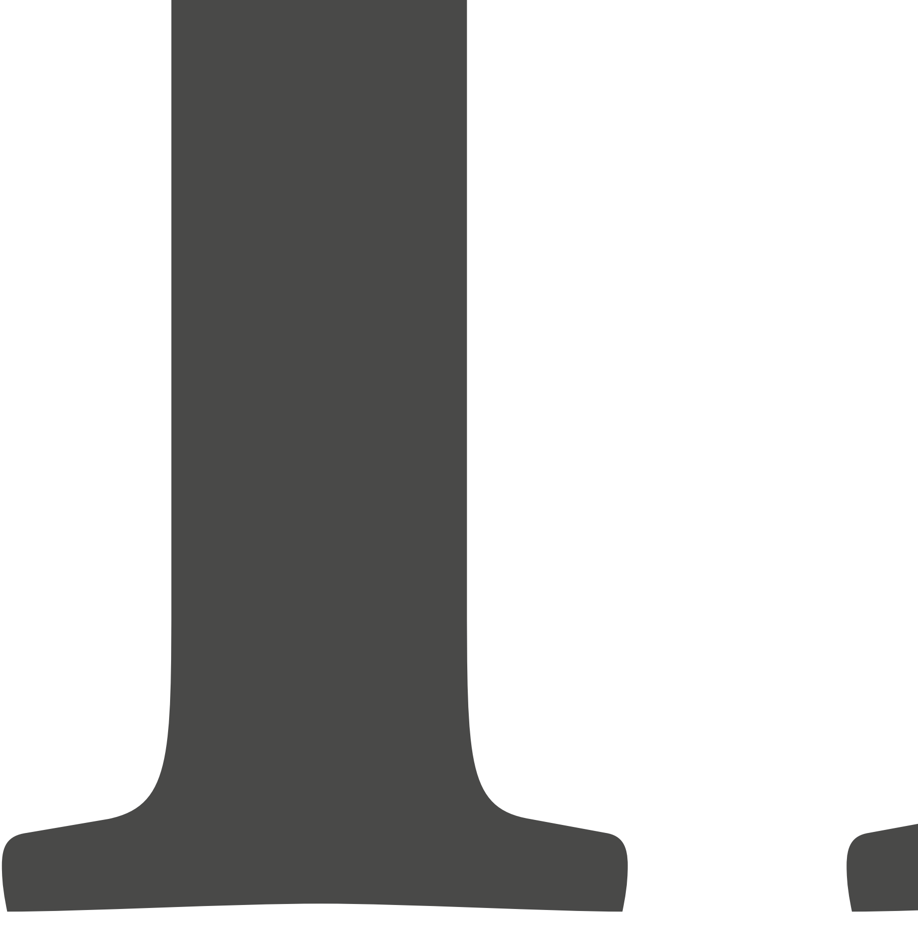






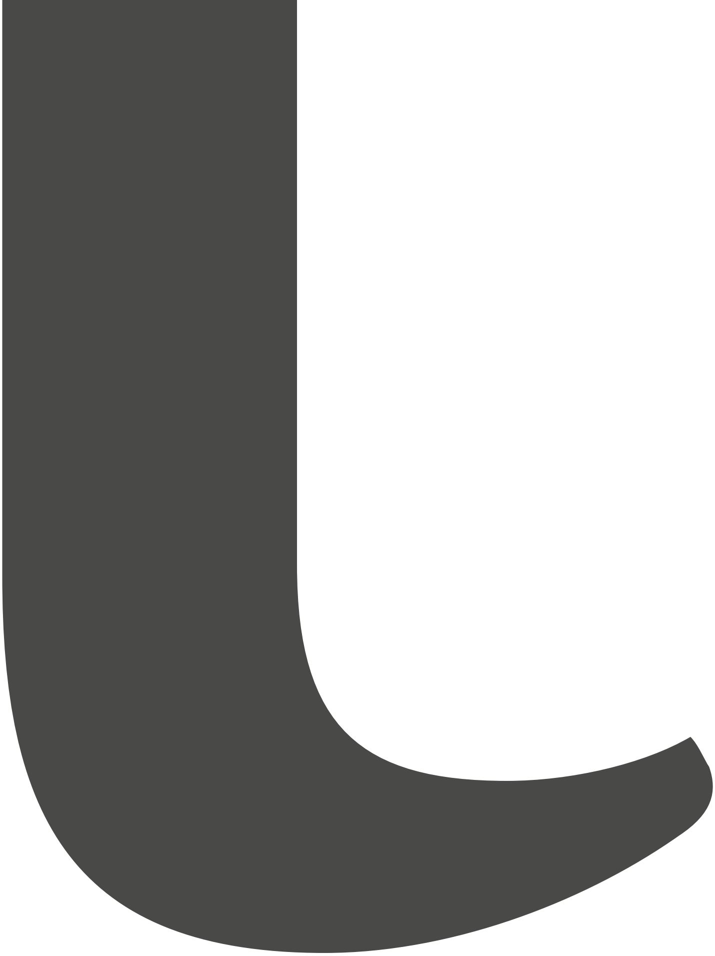


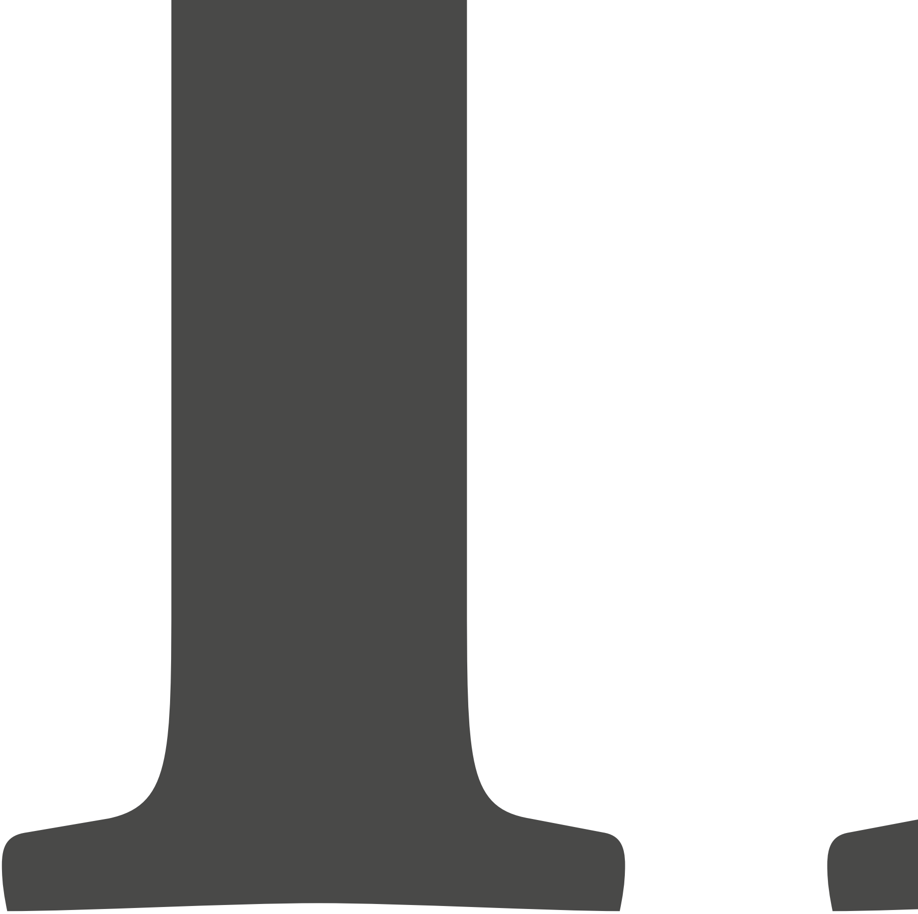
V



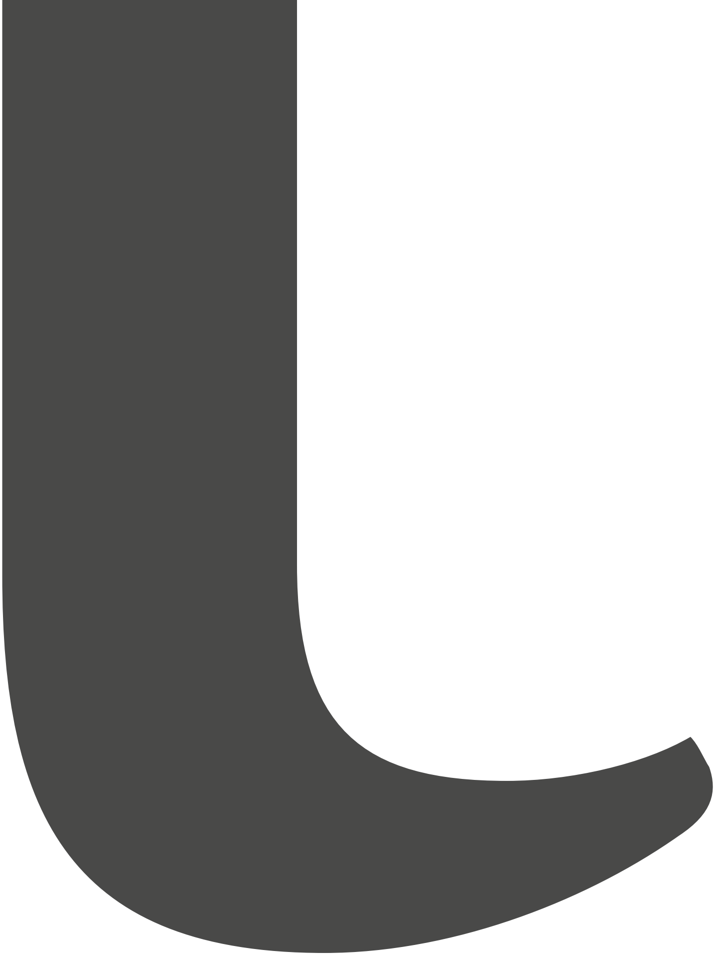
,

S





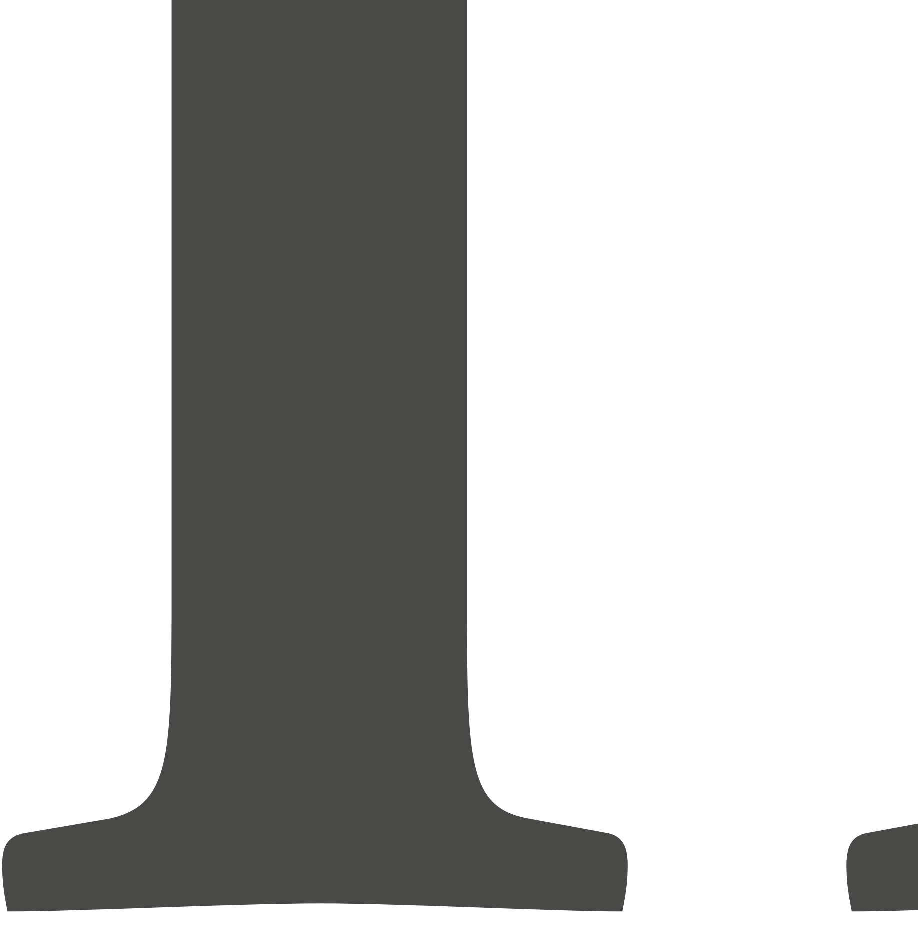
a



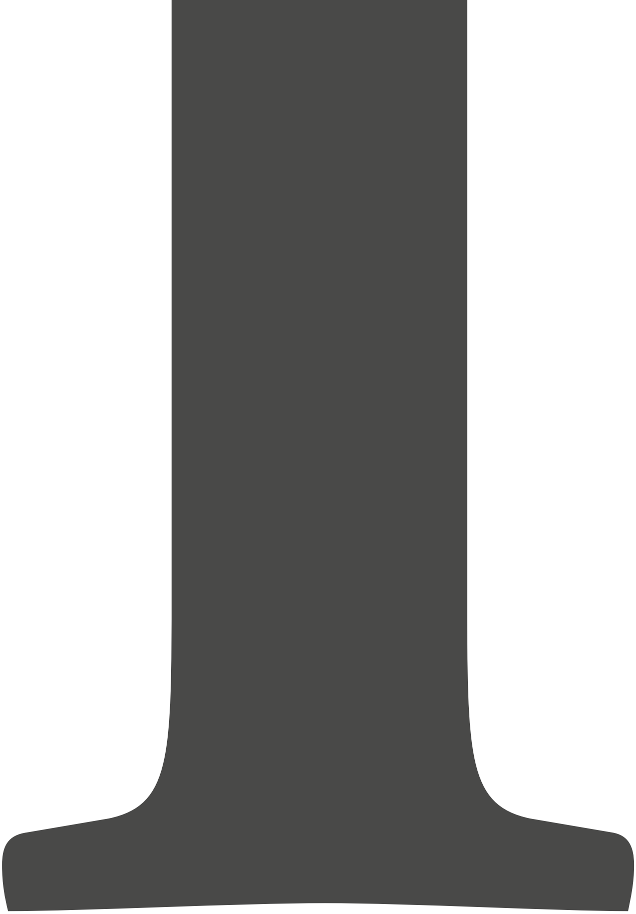
a

V

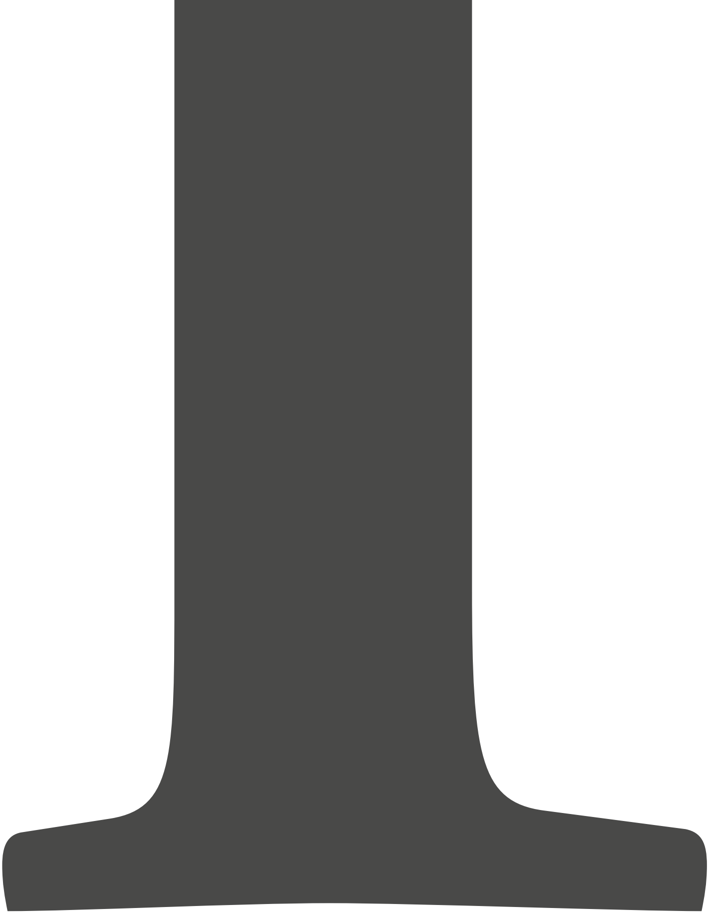
y

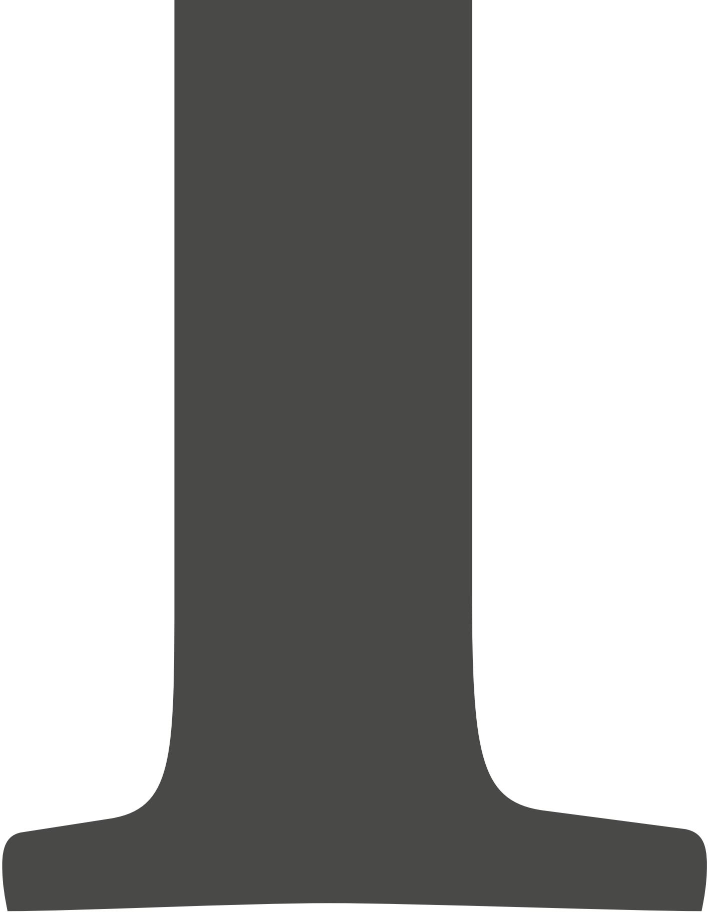


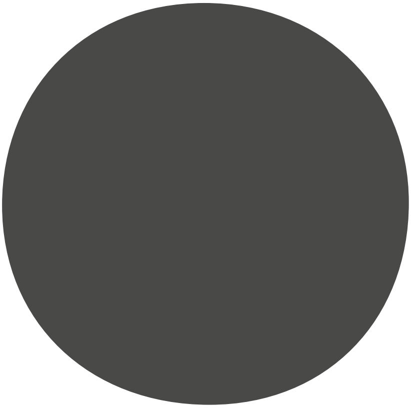
V

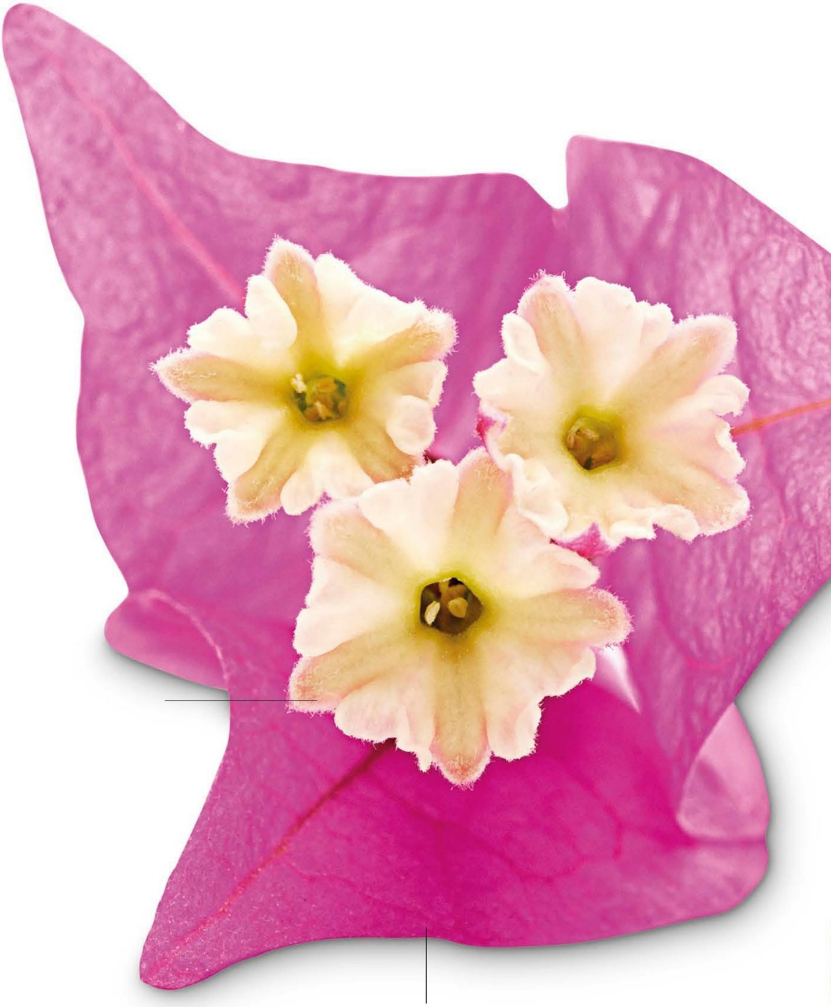


S









T

g

C

a

p

T

b

sh

b

re

V

T

h

b

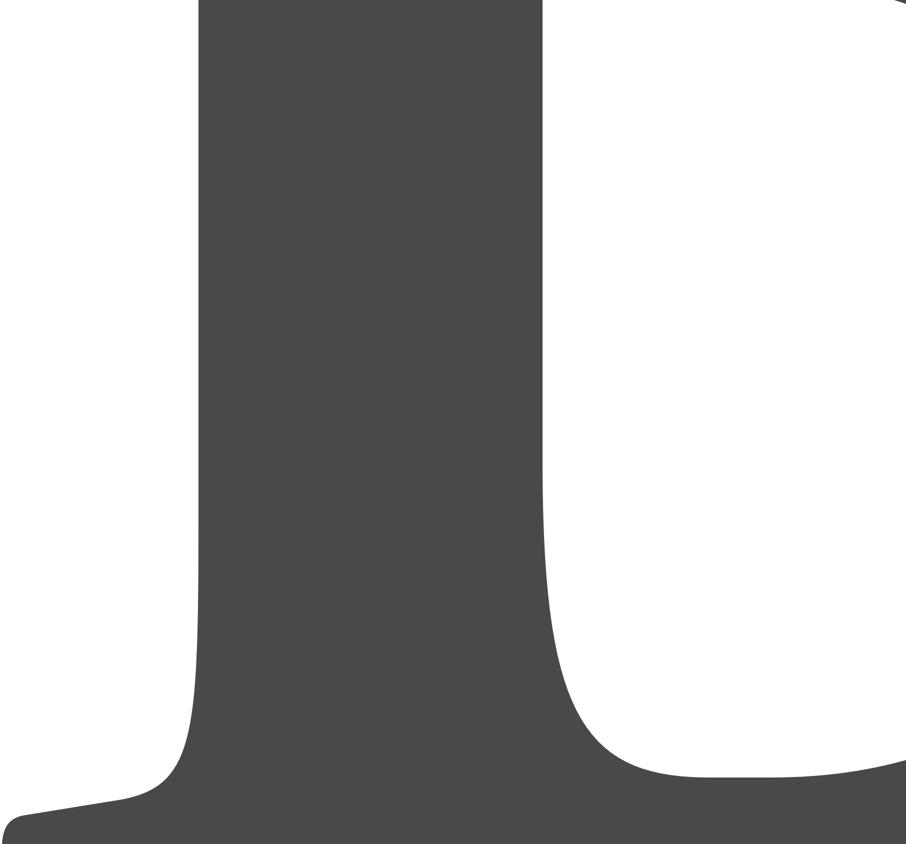
th

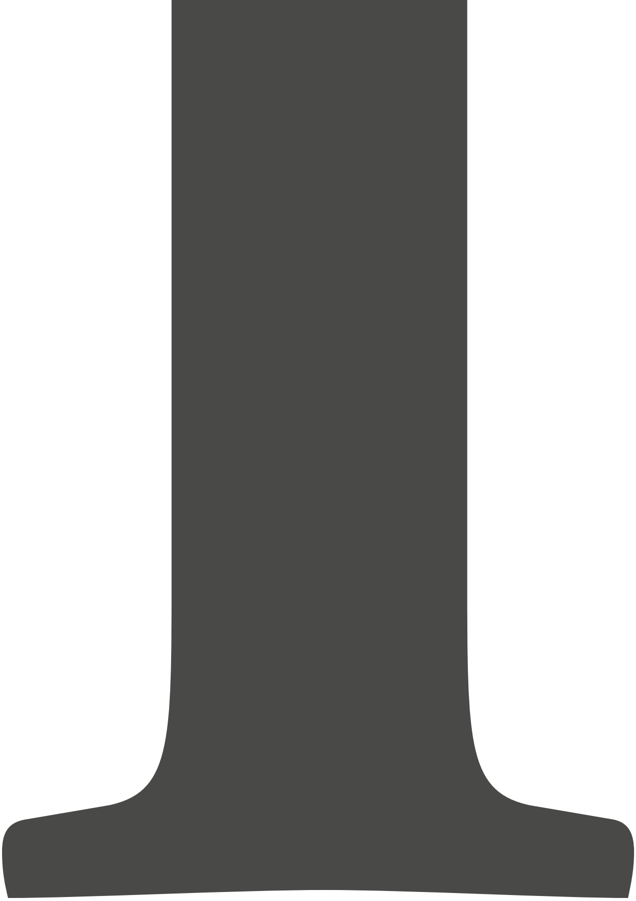
m

T

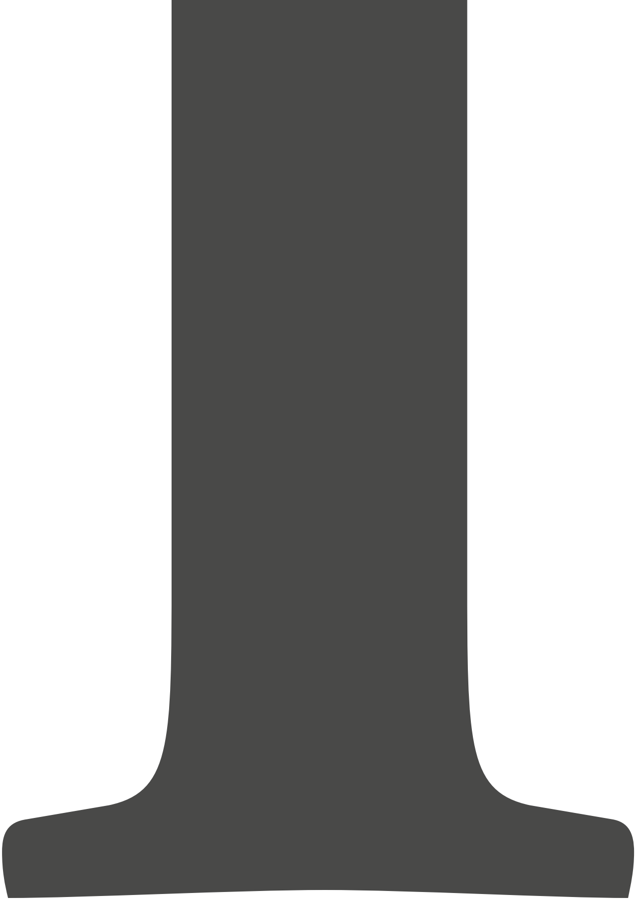
a

p

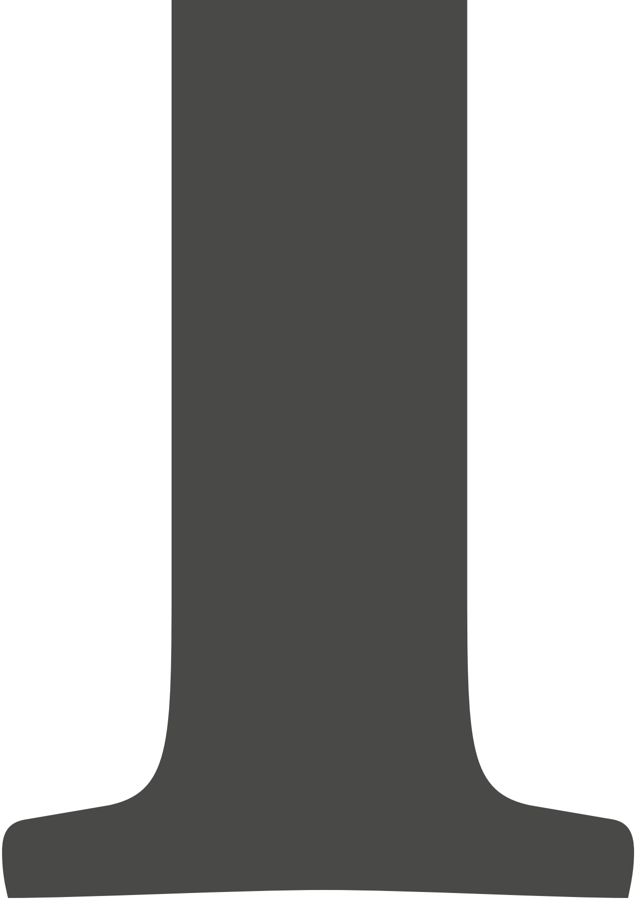




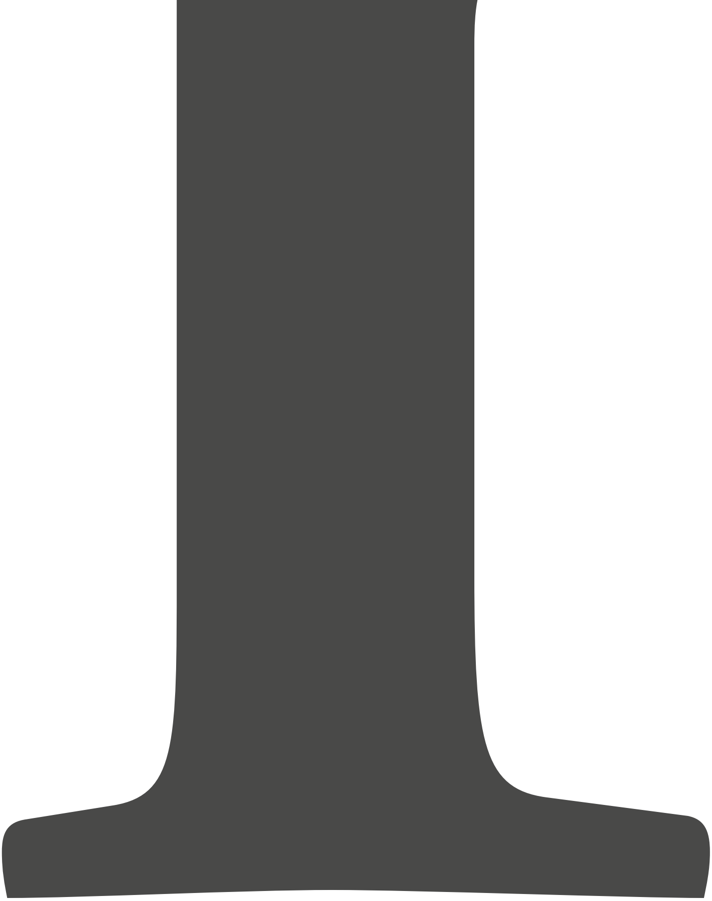
V

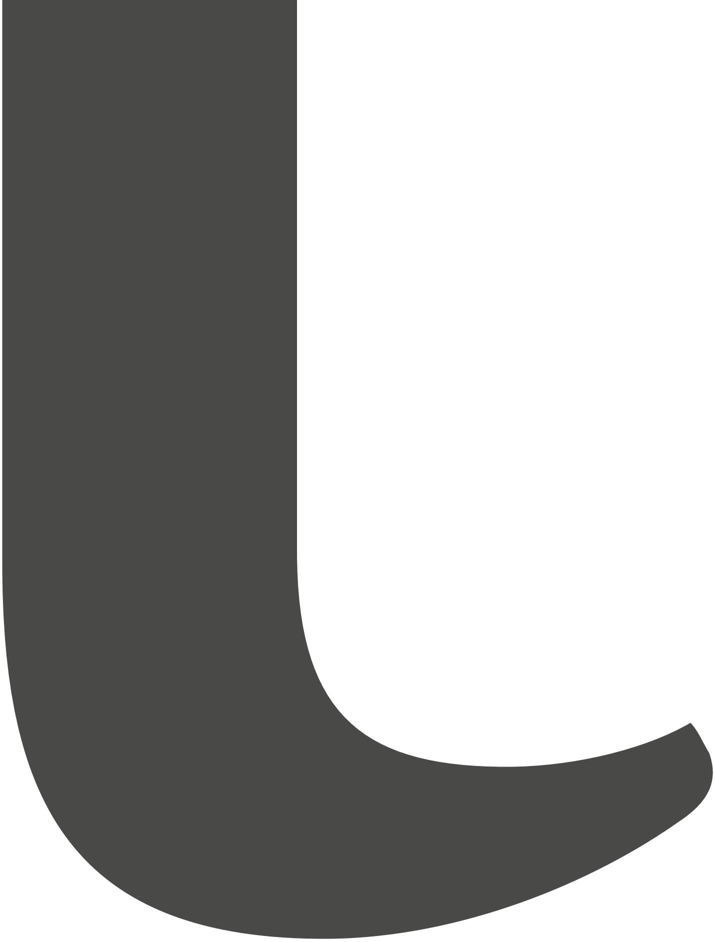


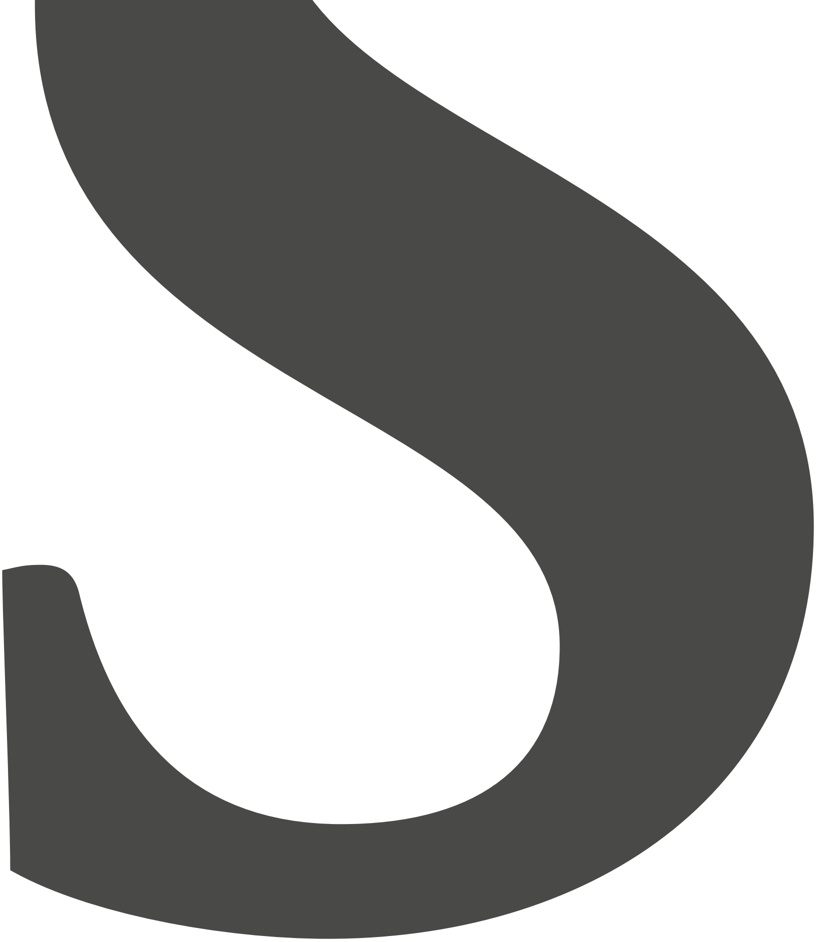
1

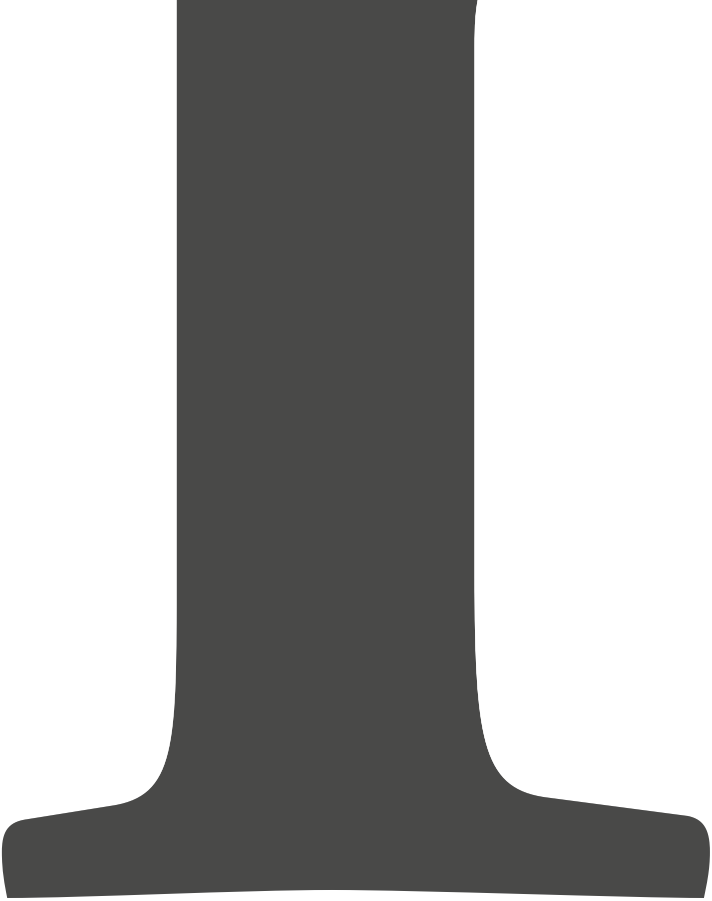


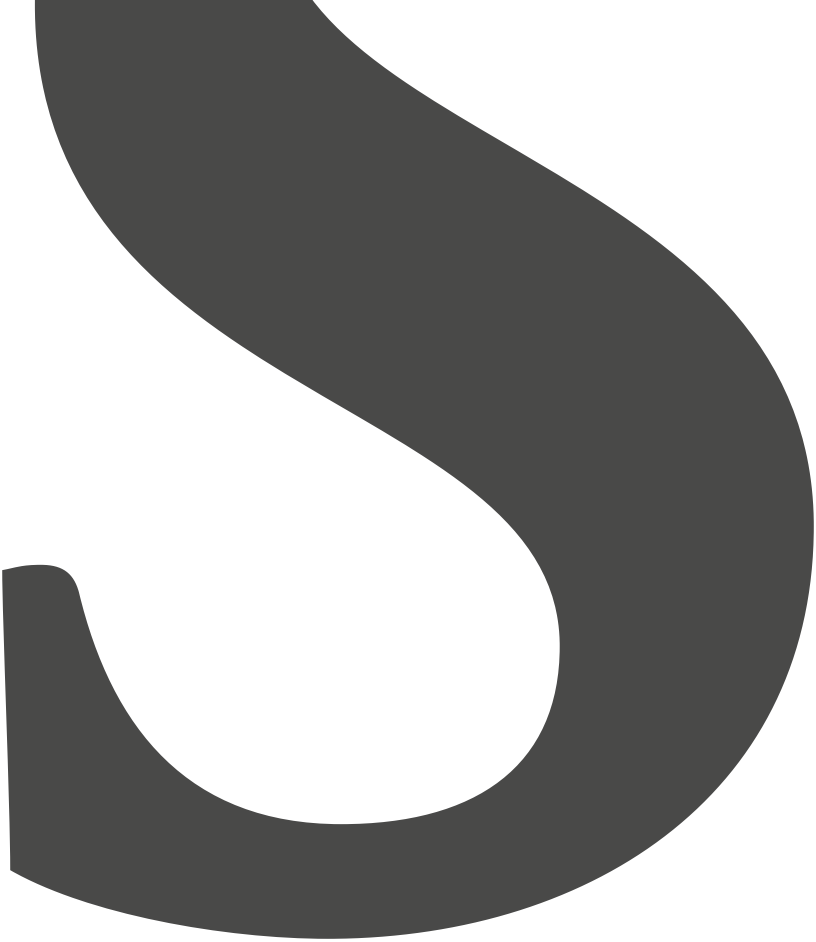
a



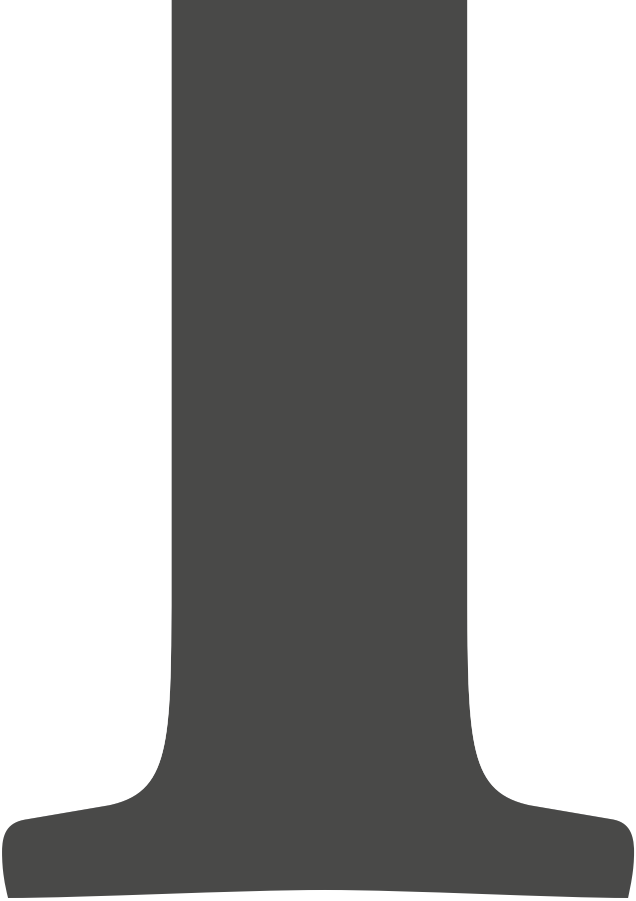




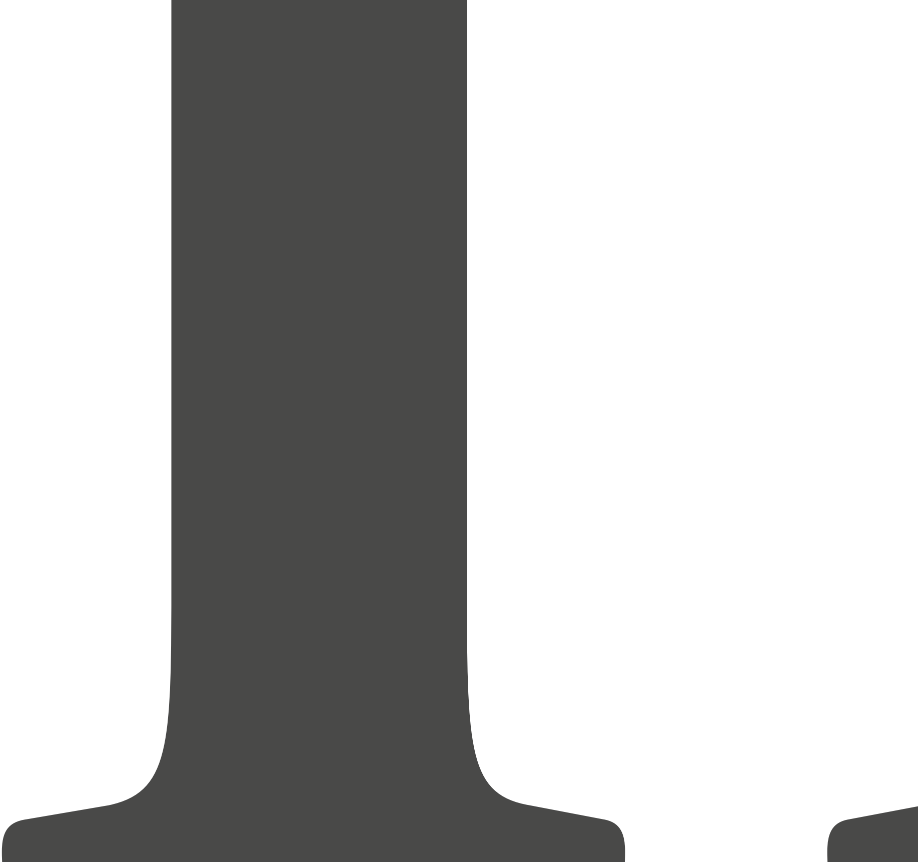


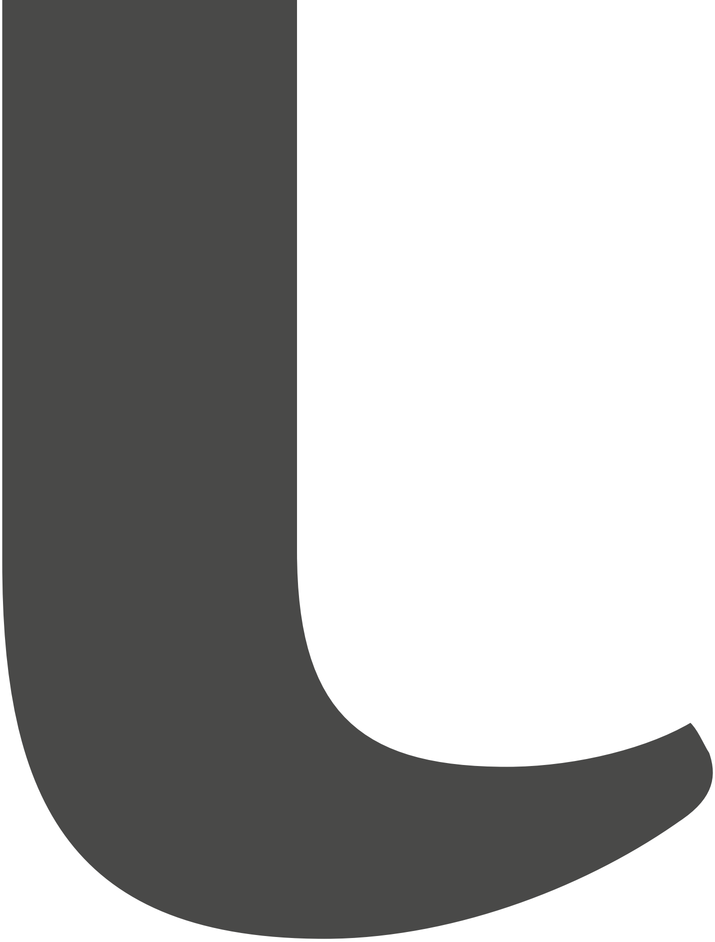


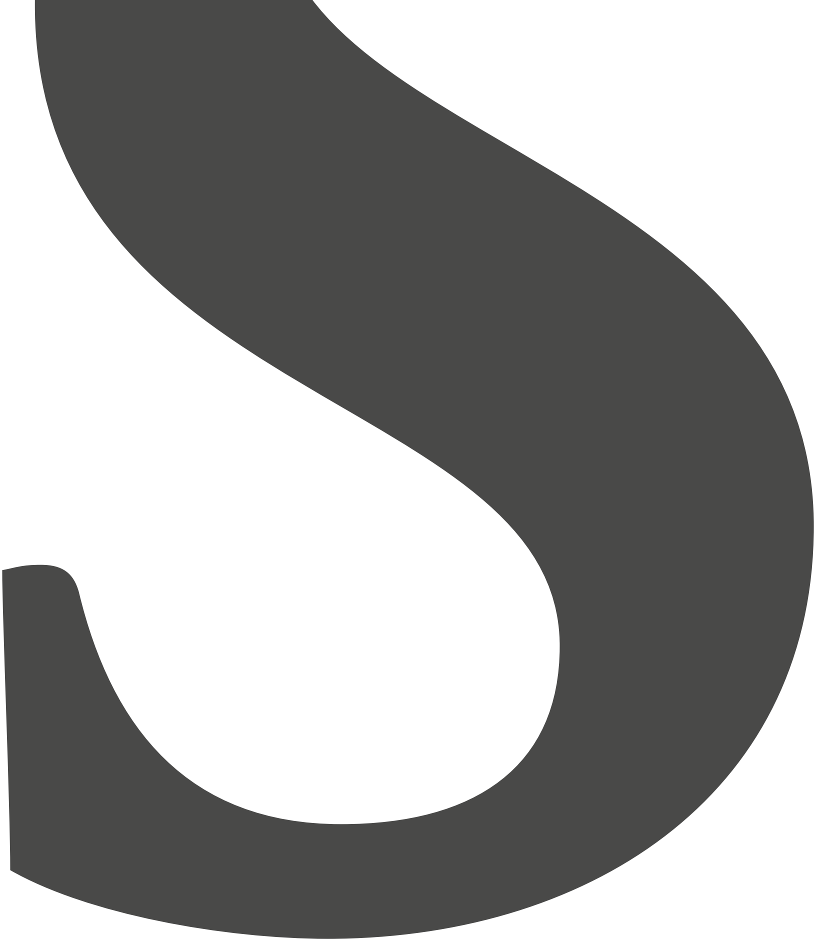
1

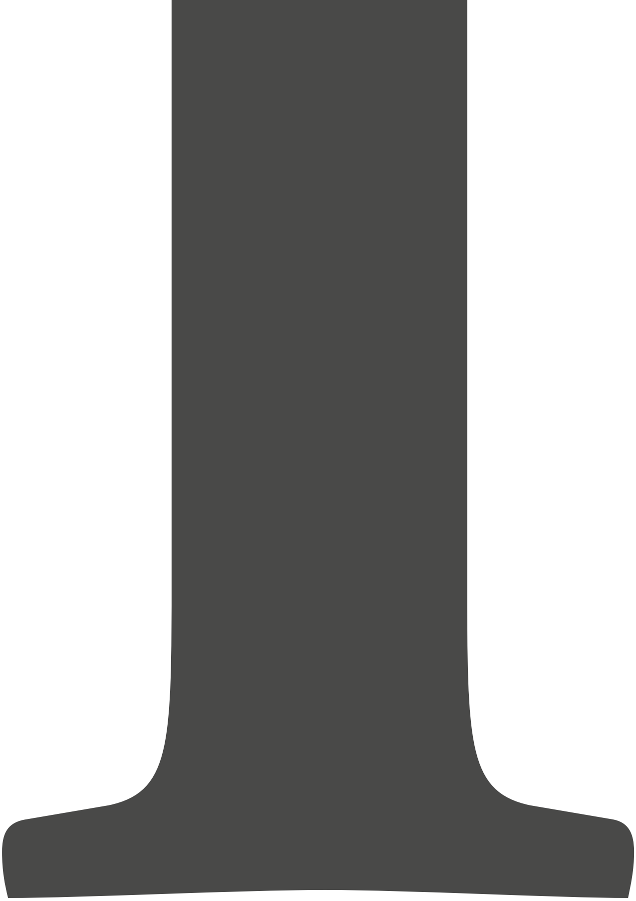


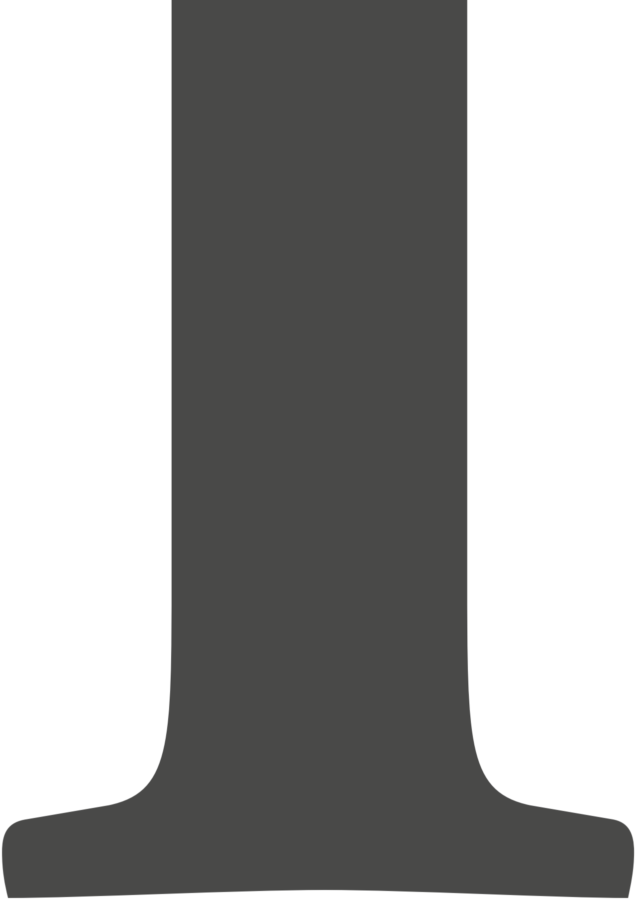
g



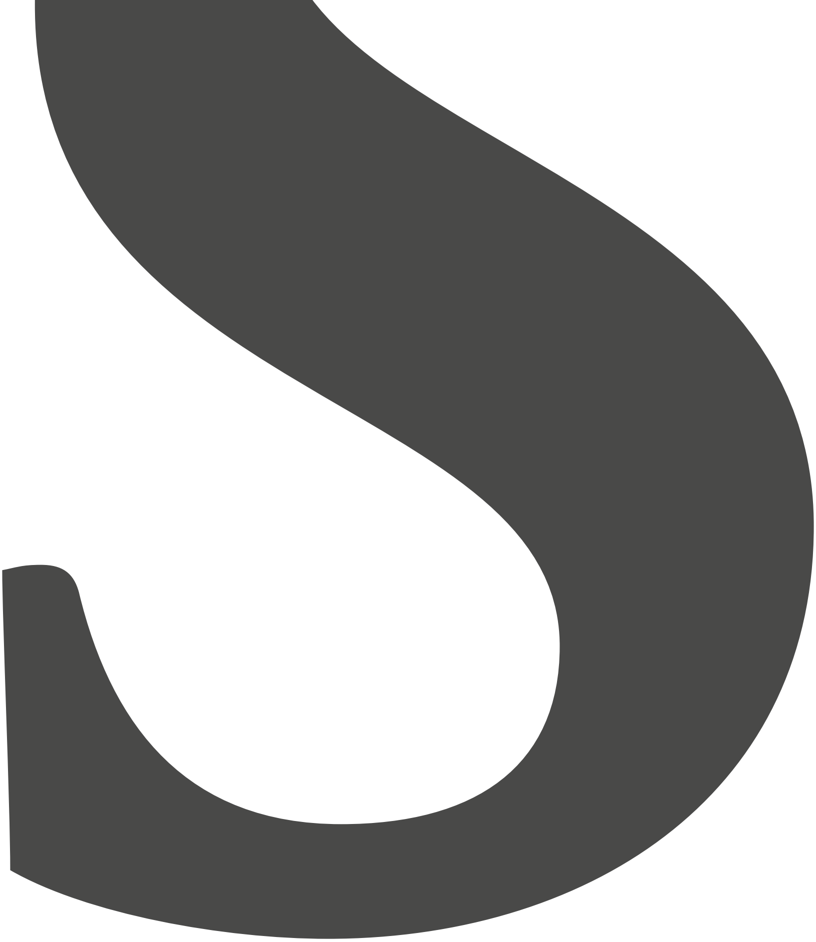


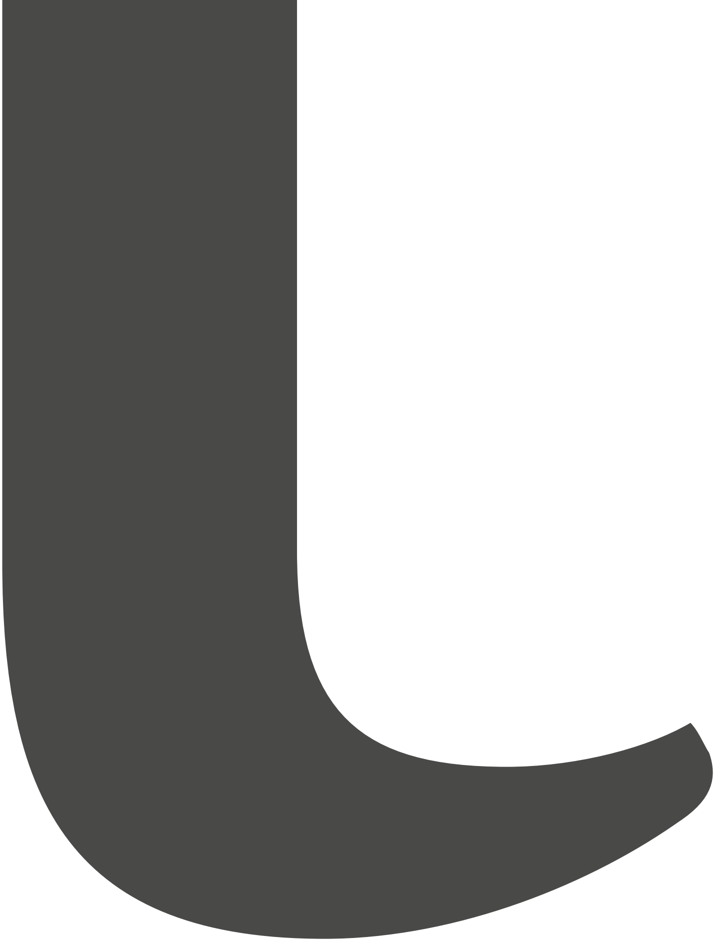


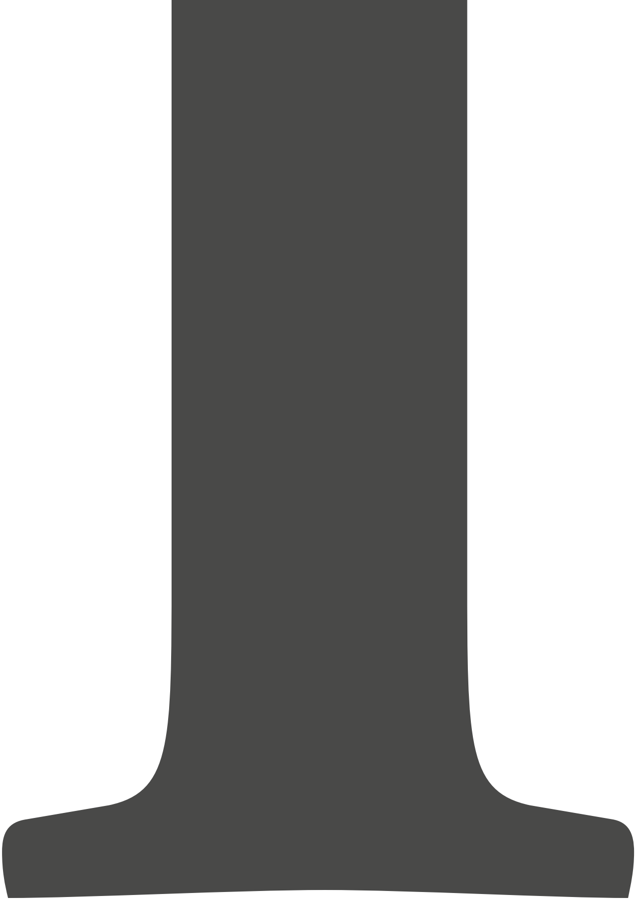




p

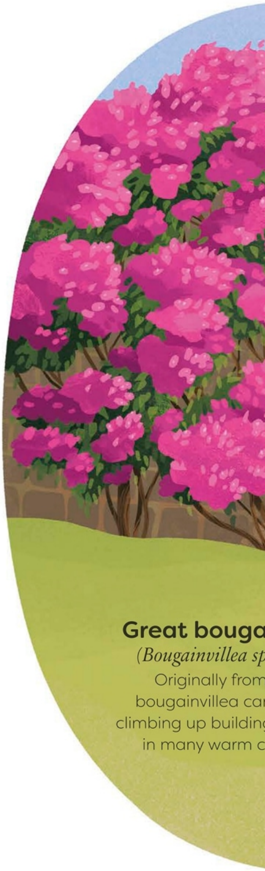




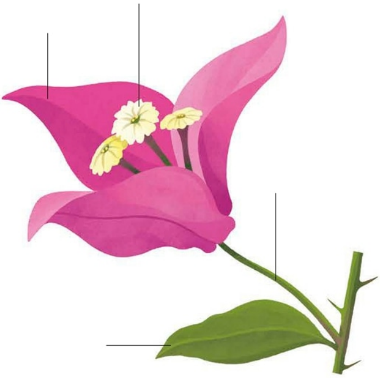


!

Bougainvillea

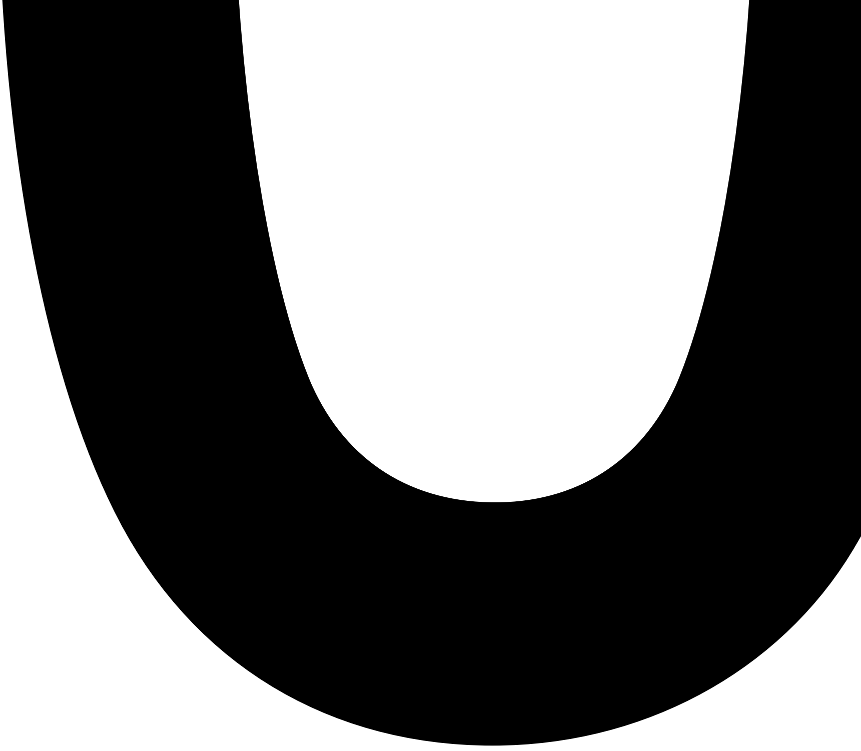


Great bouga
(Bougainvillea sp
Originally from
bougainvillea ca
climbing up buildin
in many warm c



Two types of leaf

Bougainvillea has ordinary green leaves as well as special pink leaves, or bracts. The bracts are arranged in bunches, with several tiny white flowers in the middle. Sometimes, the flowers are almost completely hidden by the much larger bracts.

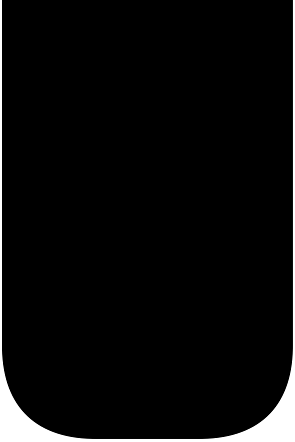


U

[redacted]

V

[redacted]



B

le

o

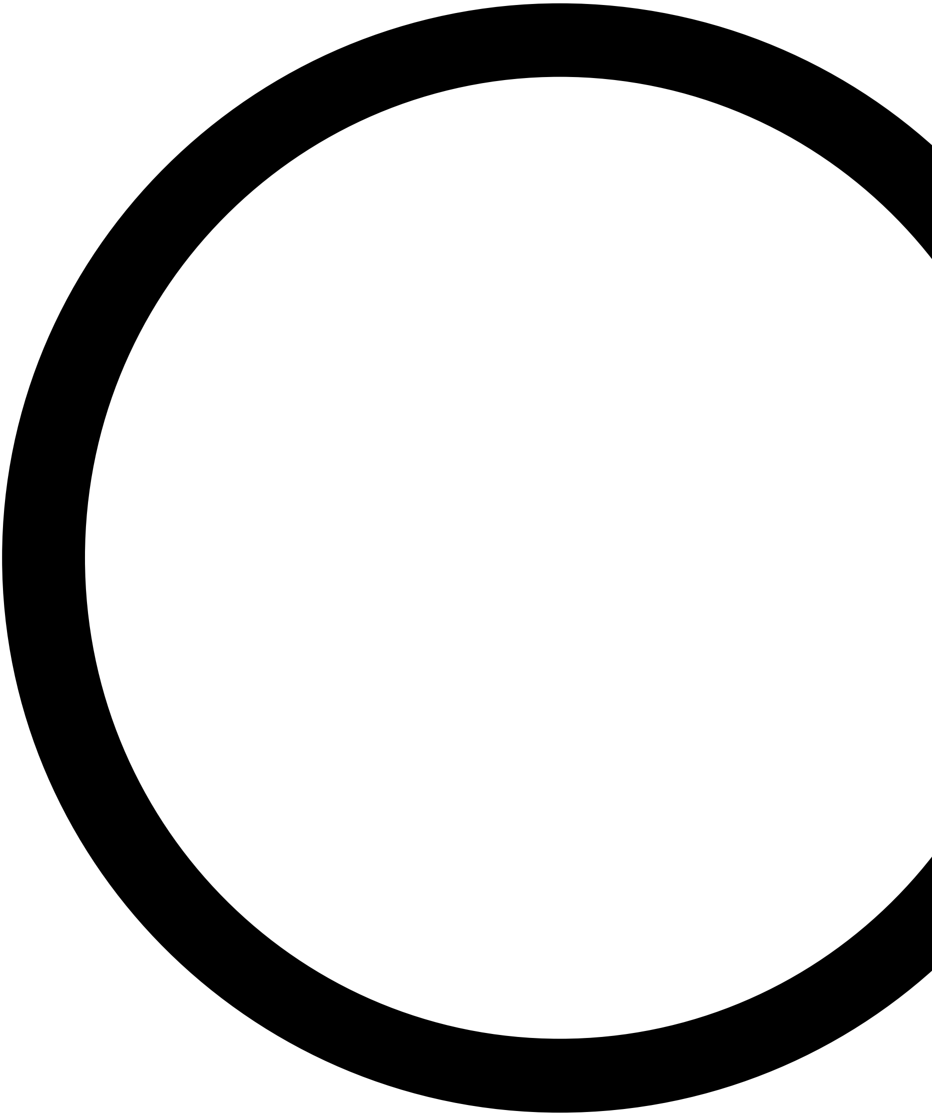
in

fl

th

h

(



b

C

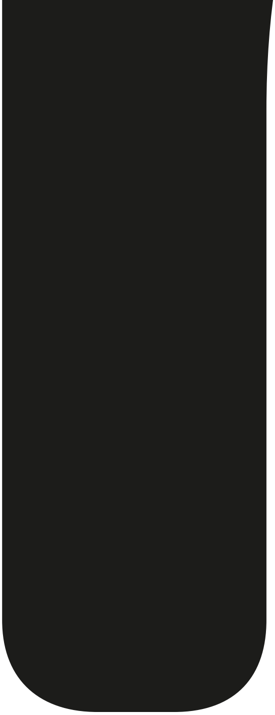
in

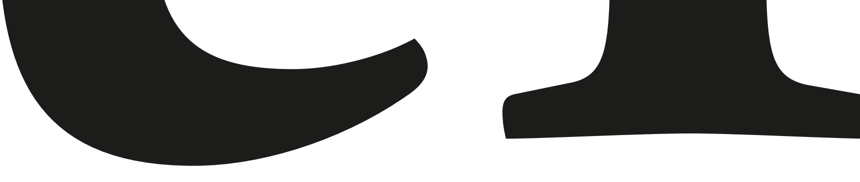
B

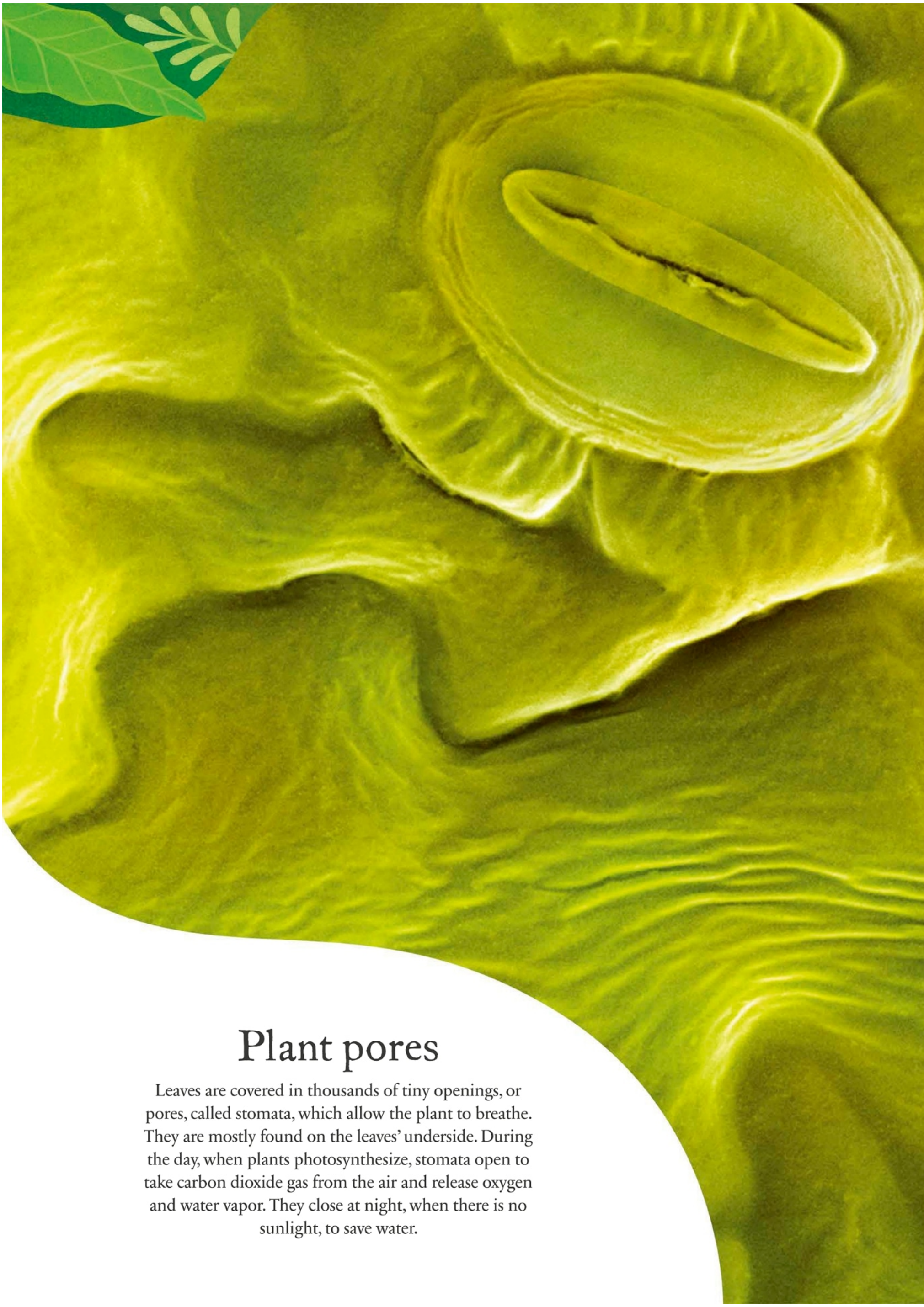
L

S

F



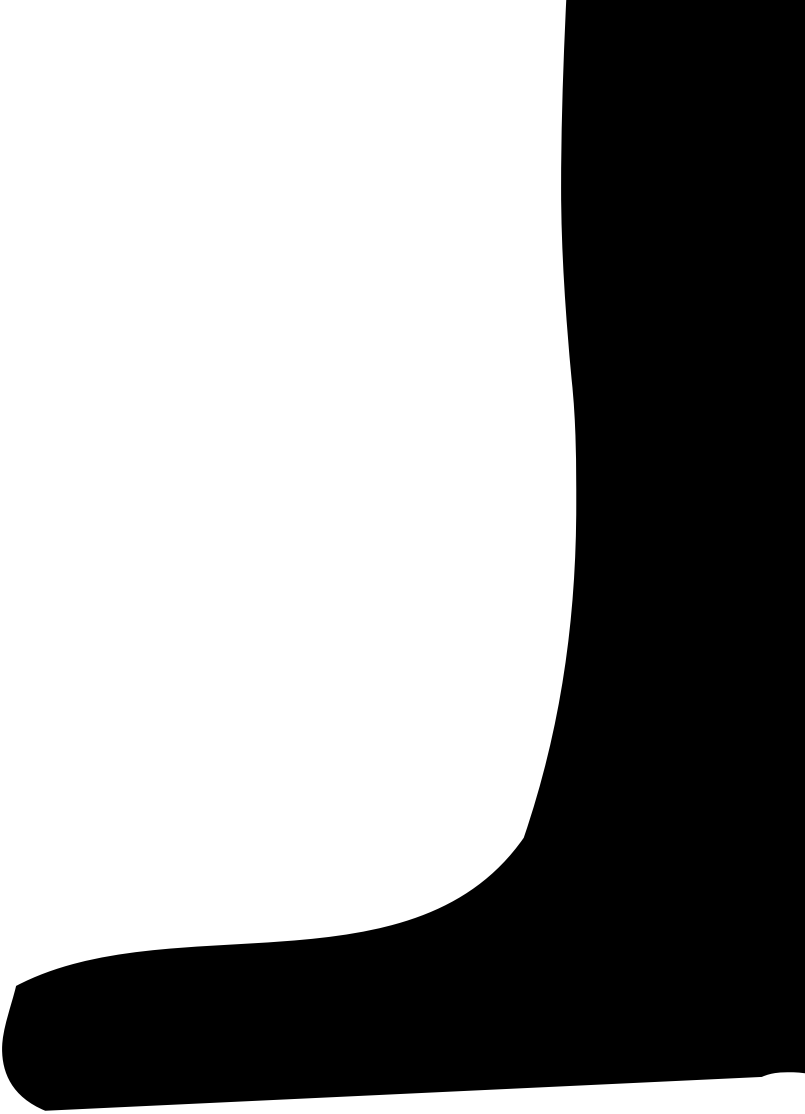


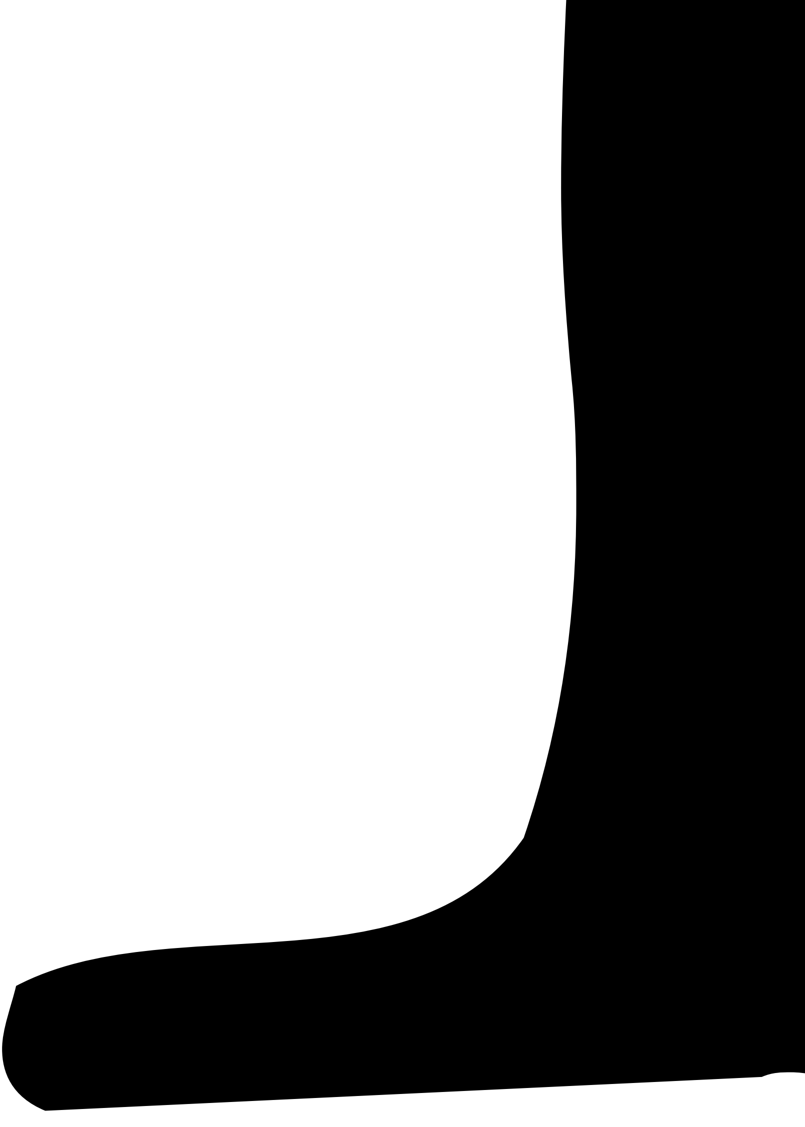


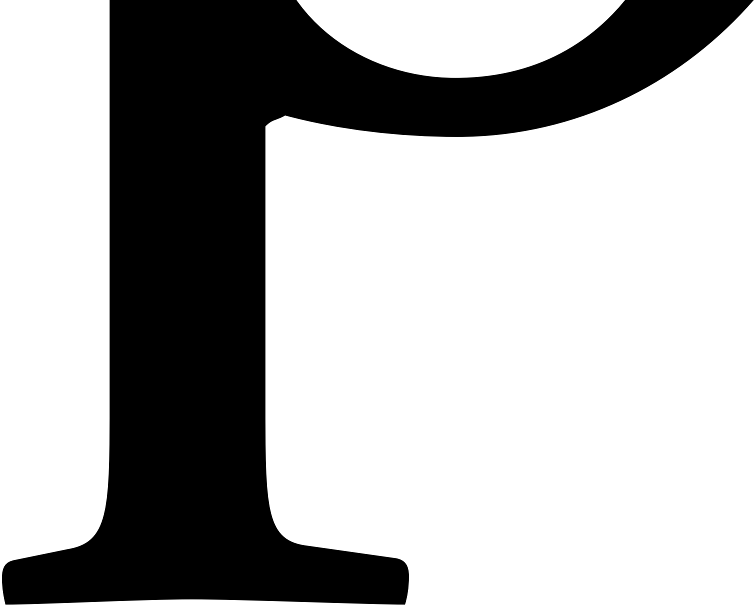
Plant pores

Leaves are covered in thousands of tiny openings, or pores, called stomata, which allow the plant to breathe. They are mostly found on the leaves' underside. During the day, when plants photosynthesize, stomata open to take carbon dioxide gas from the air and release oxygen and water vapor. They close at night, when there is no sunlight, to save water.

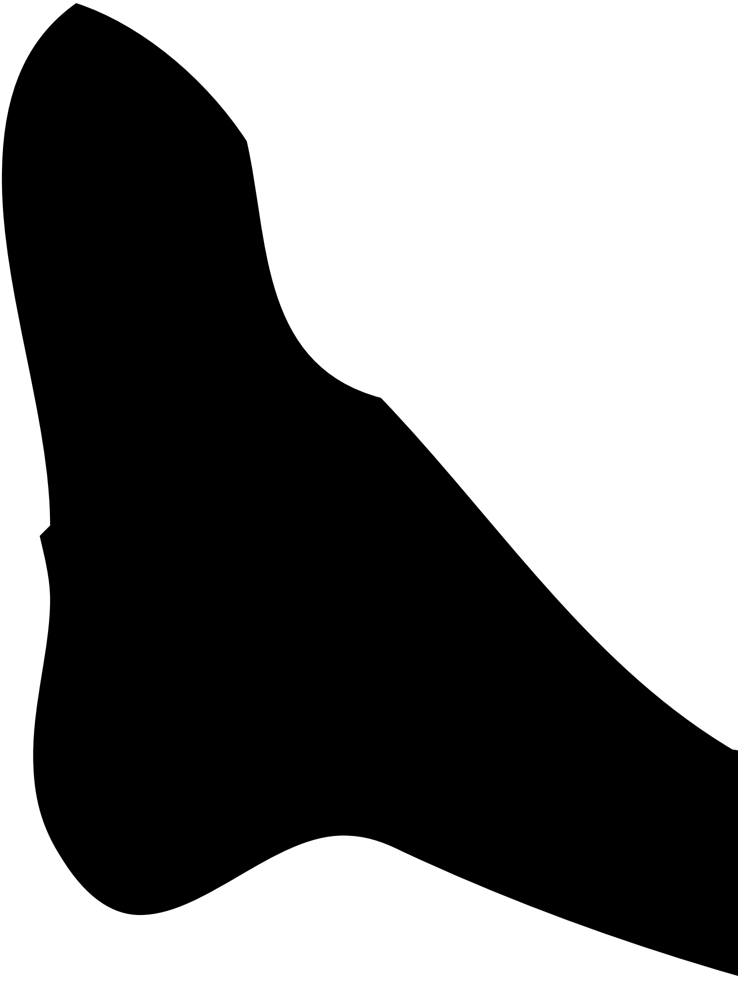
T

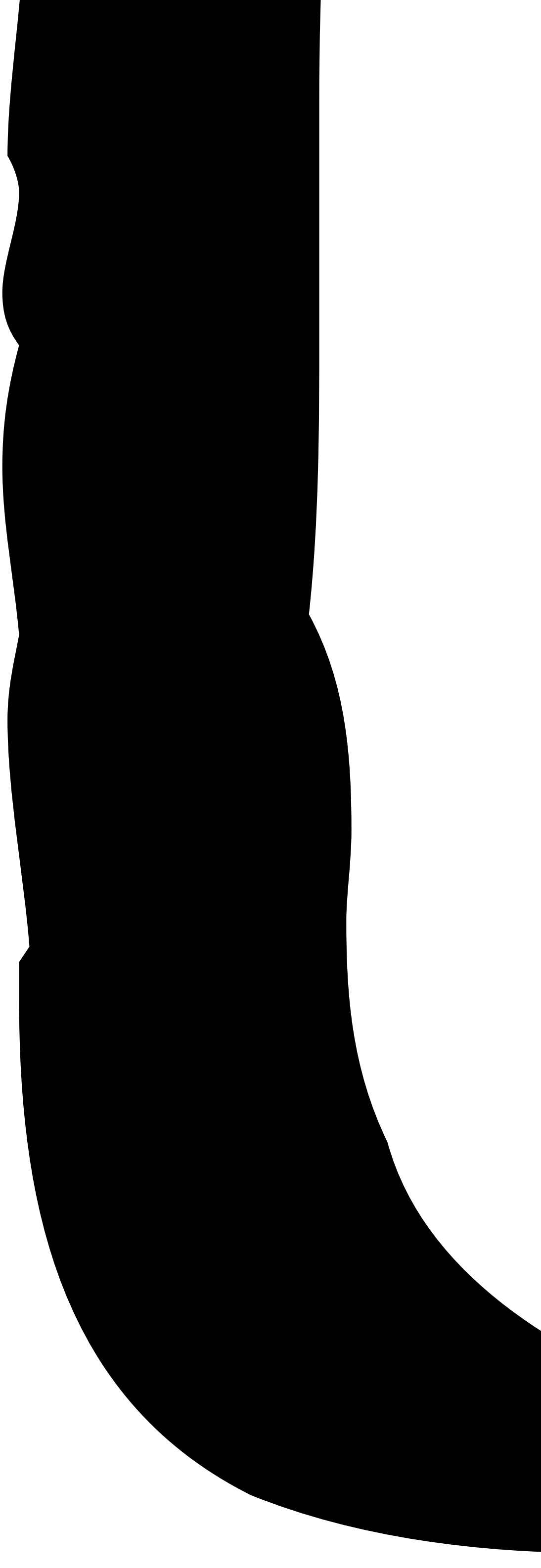


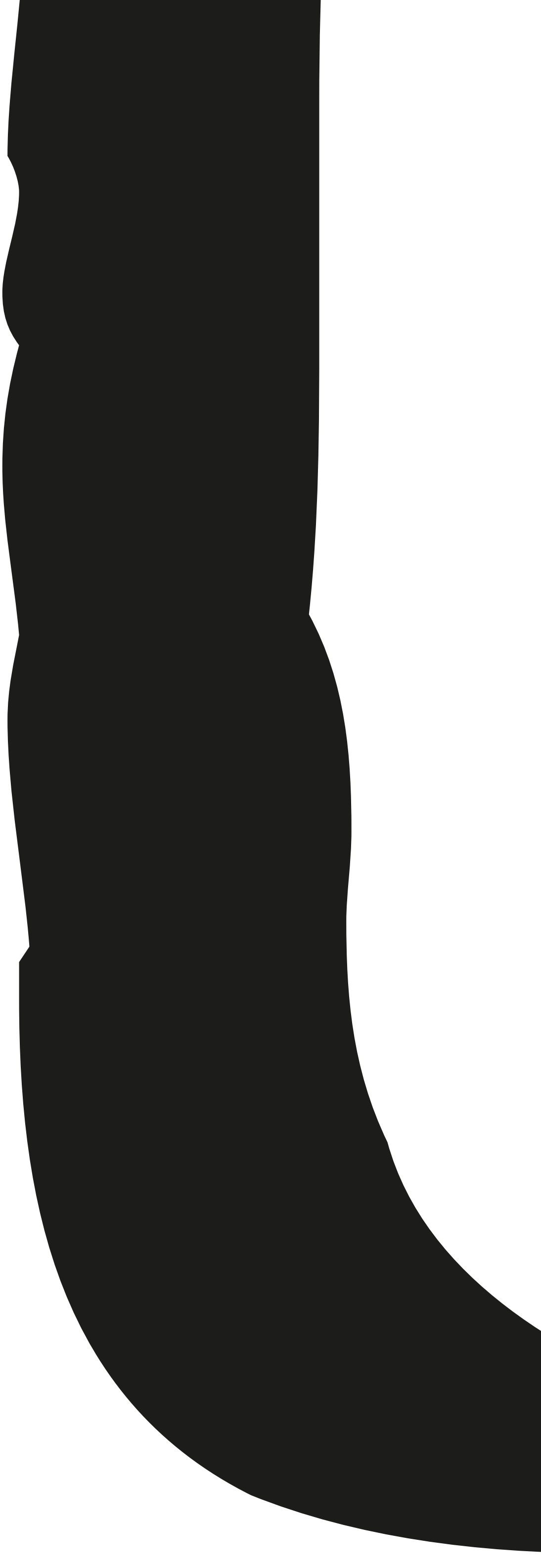


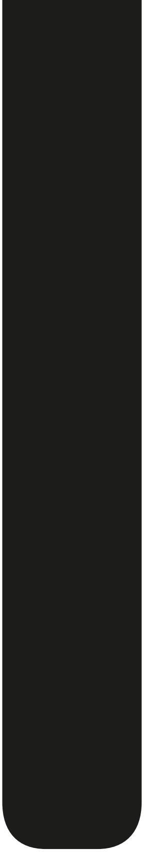


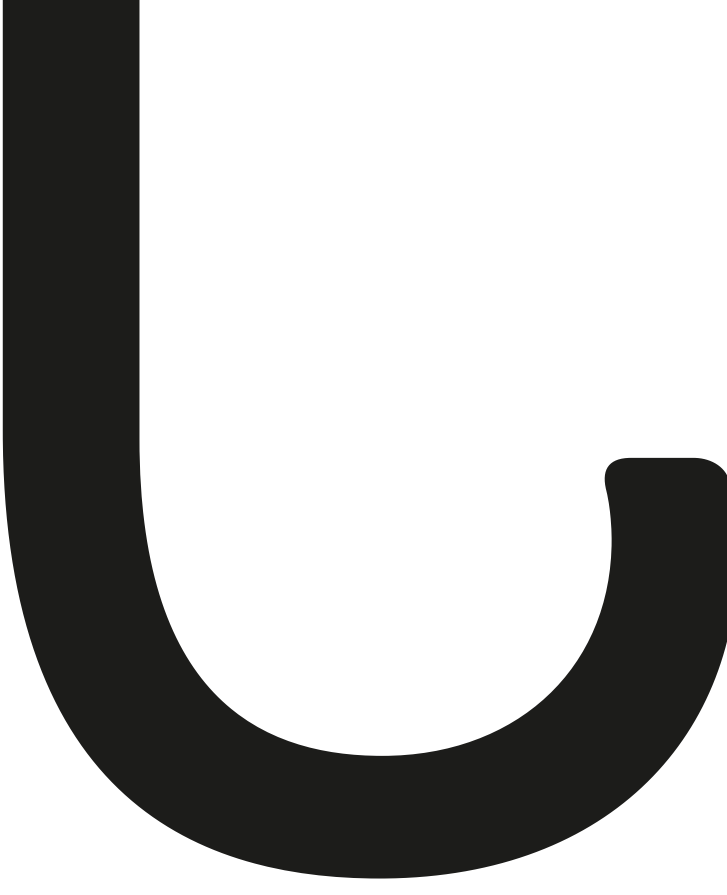
Stems and trunks

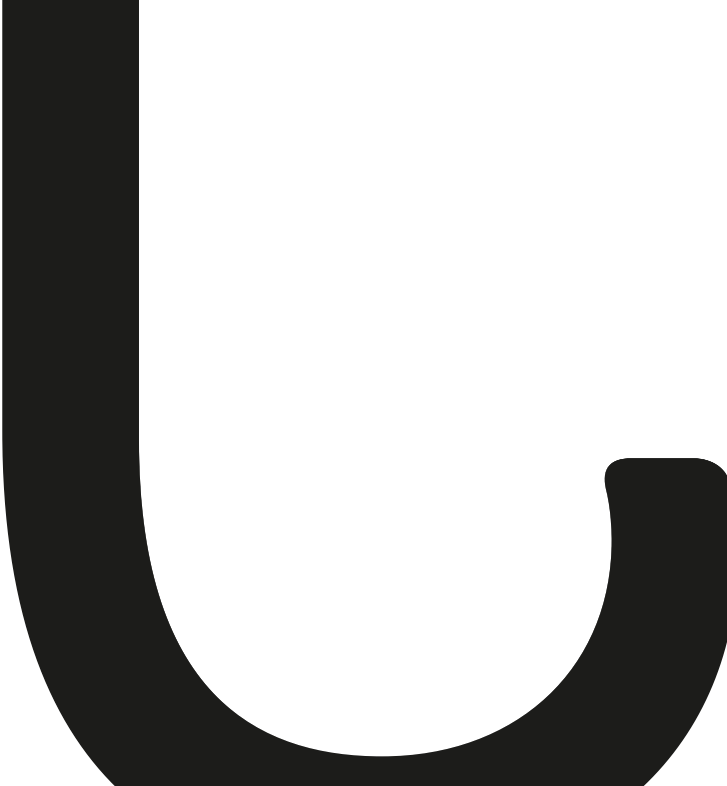


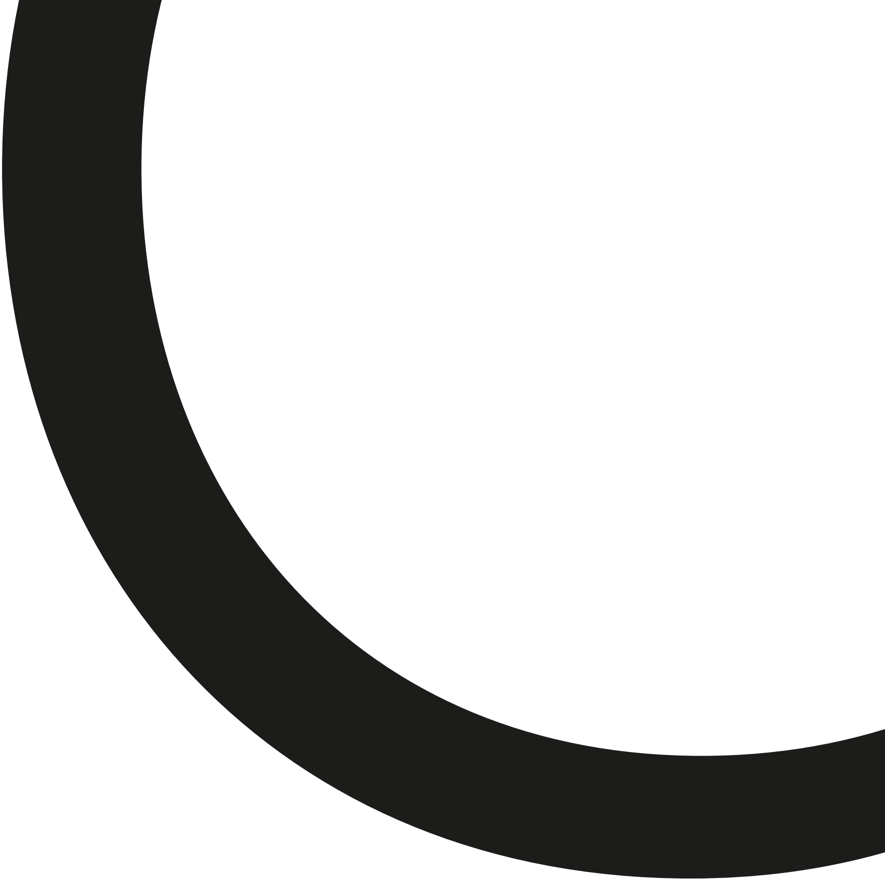


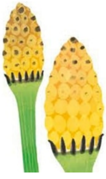


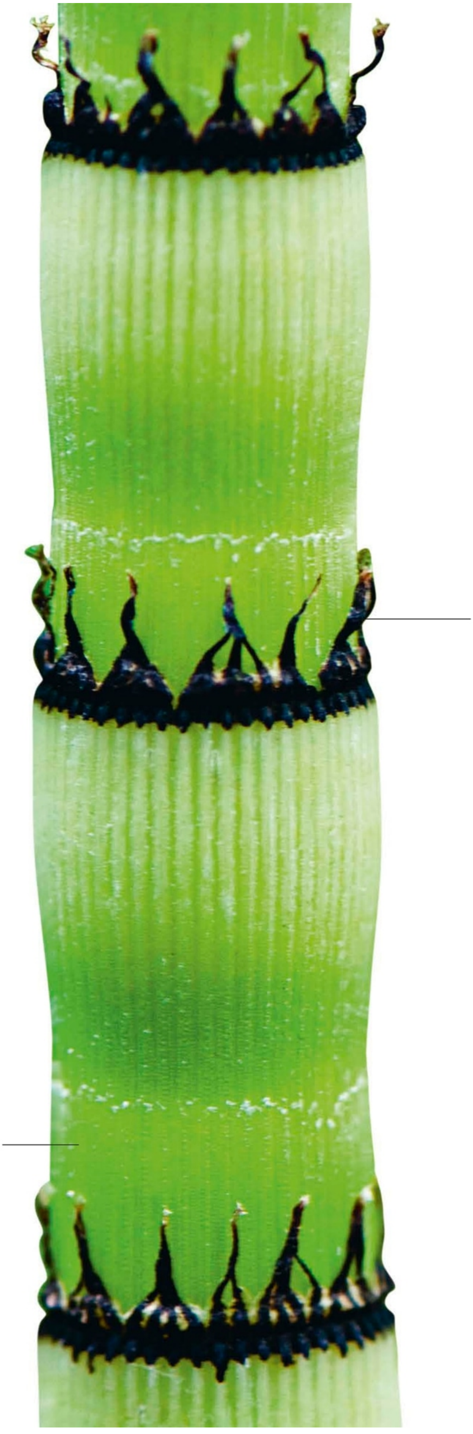


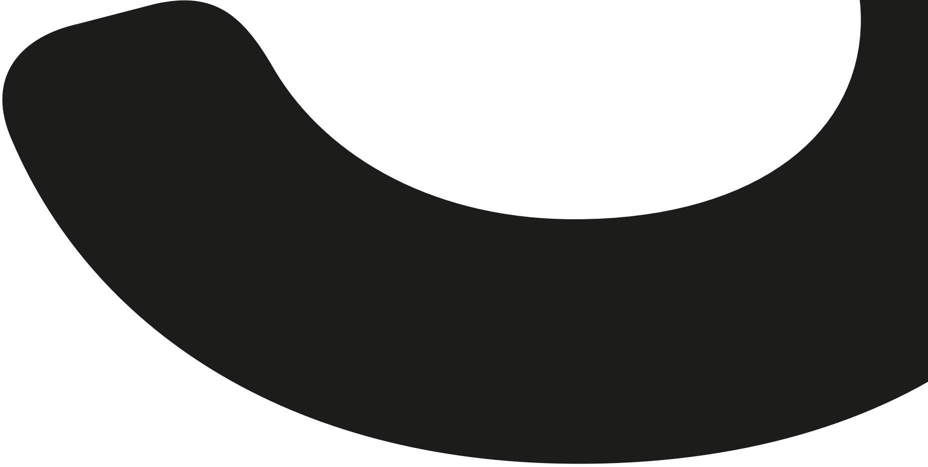










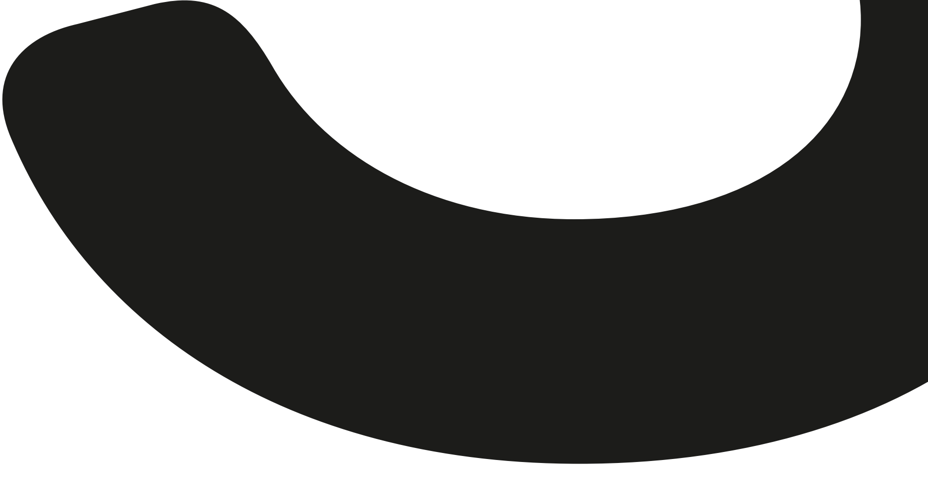


T

m

le

b



A

W

C

o

sp

W

u

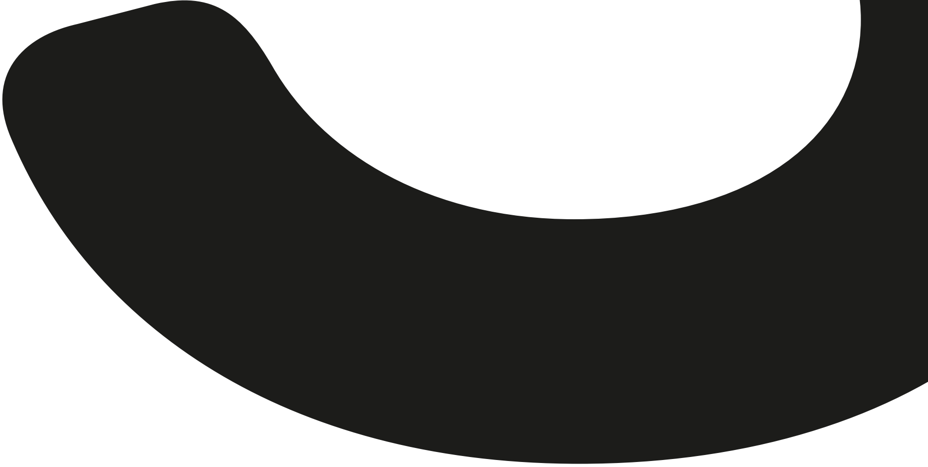
S

fo

th

T

a



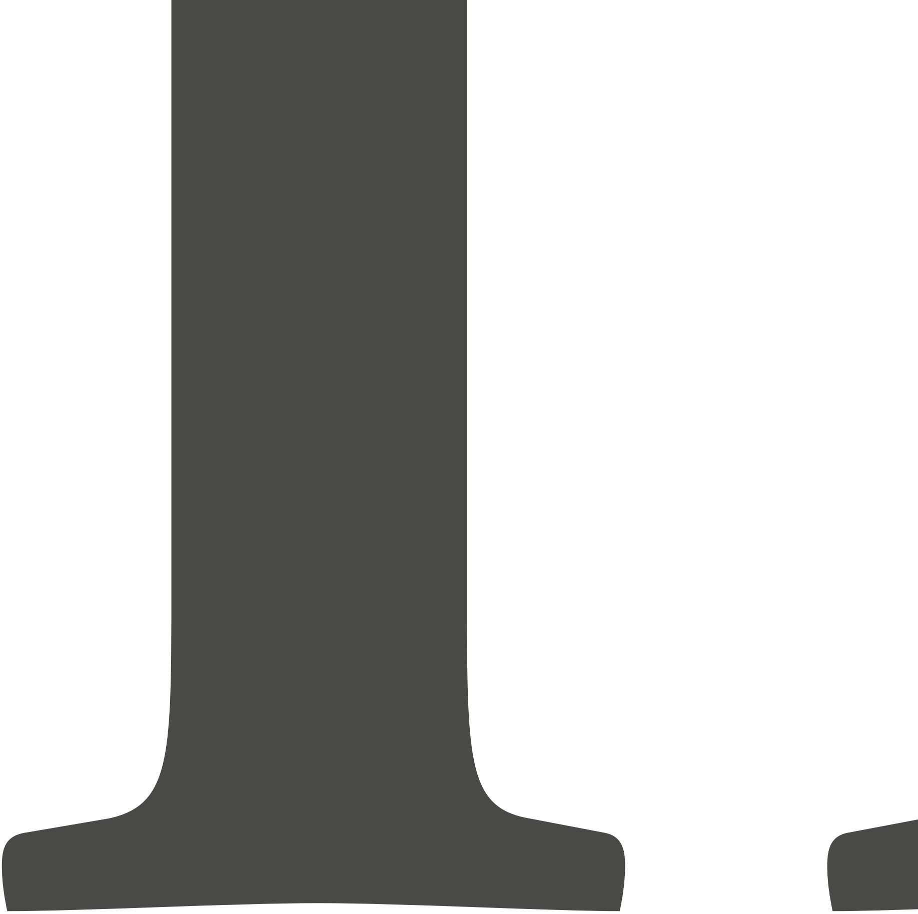
T

a

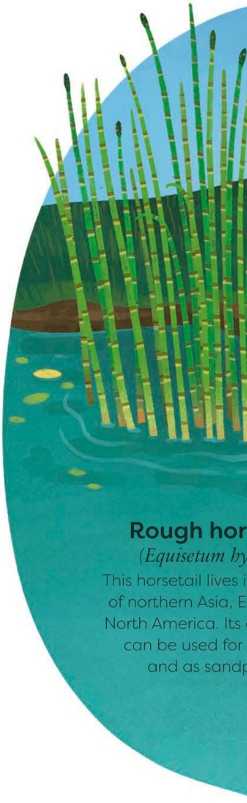
th

W

ro



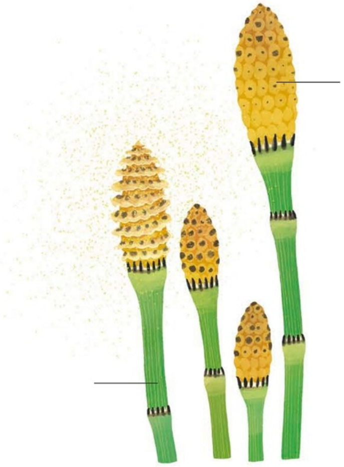
Horsetail



Rough hor

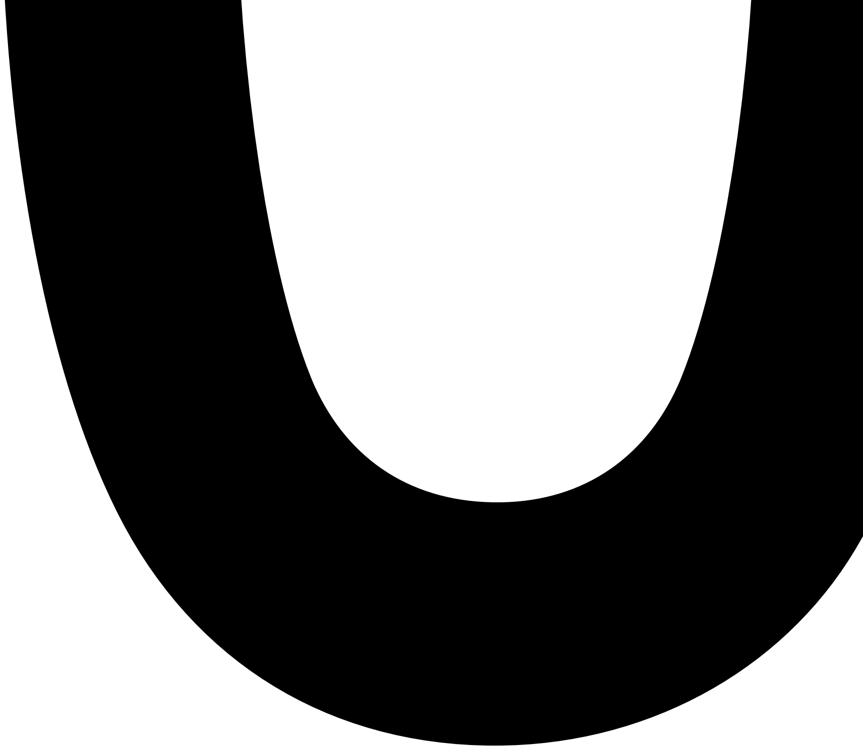
(Equisetum hy

This horsetail lives i
of northern Asia, E
North America. Its
can be used for
and as sandp



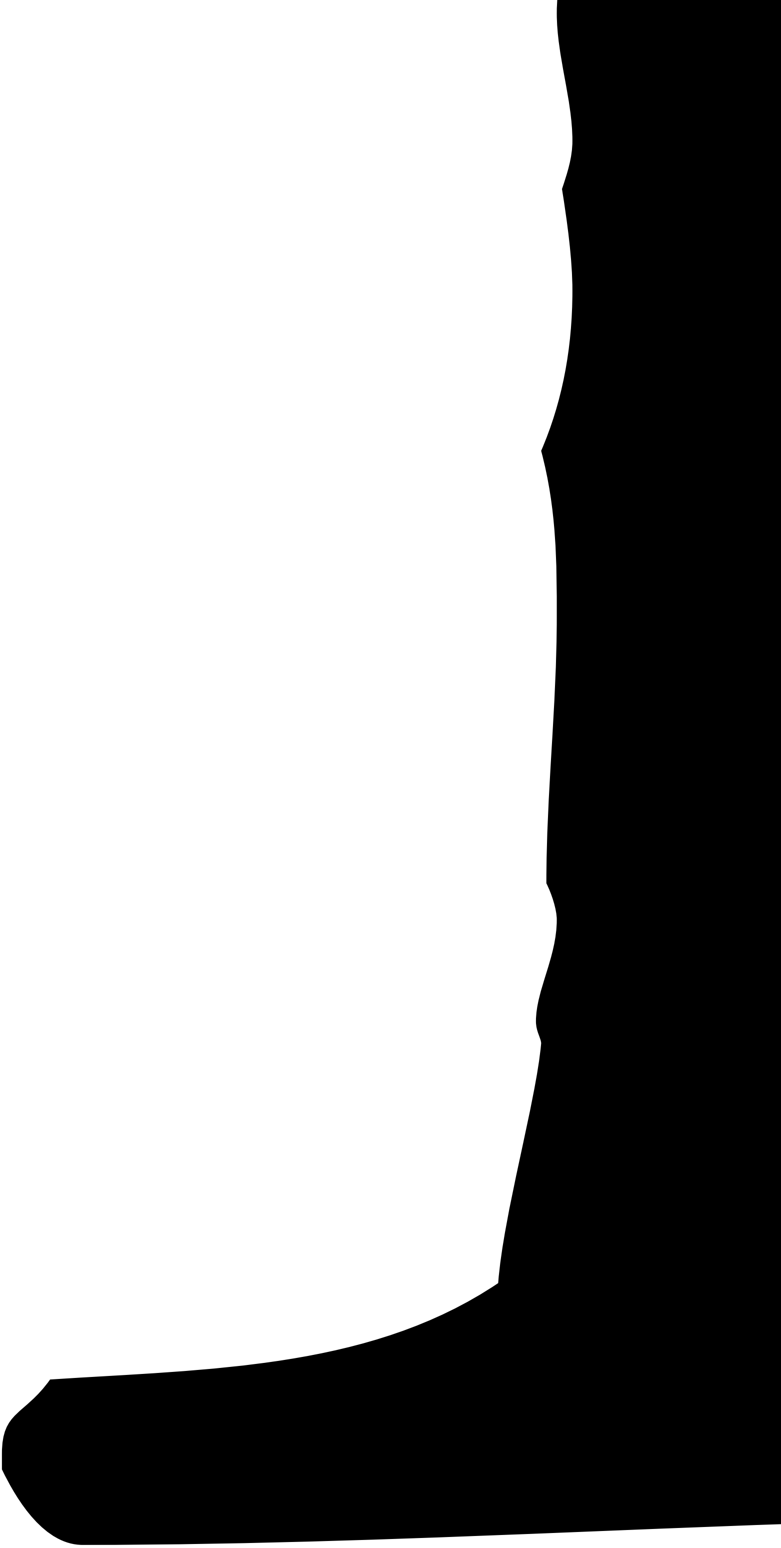
Stems with spores

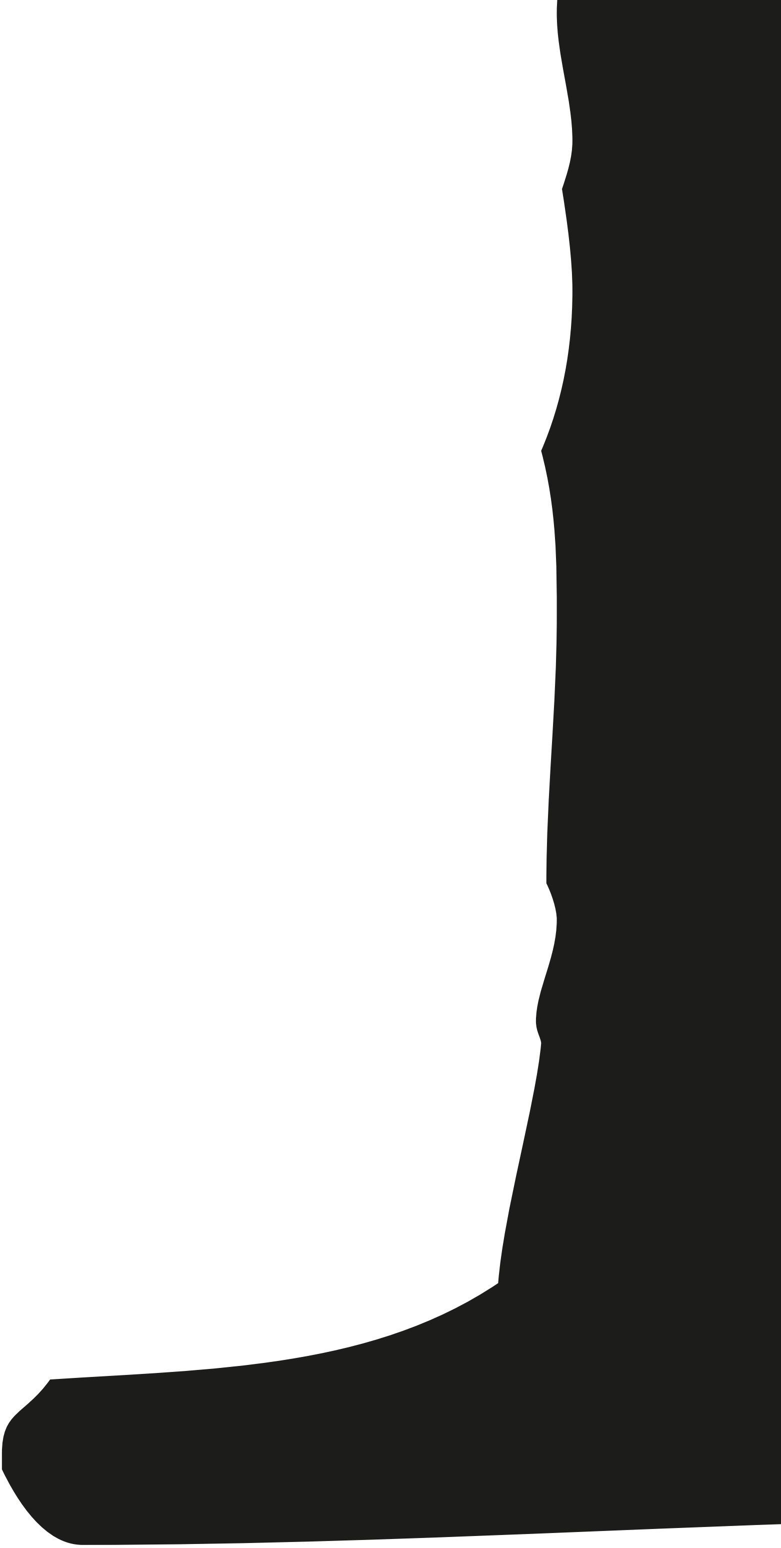
Horsetails spread not with seeds but with microscopic spores. The plant produces a lumpy structure, called a strobilus, at the top of some stems. This contains the spores, which spring from the strobilus in dry weather and are carried away on the breeze.

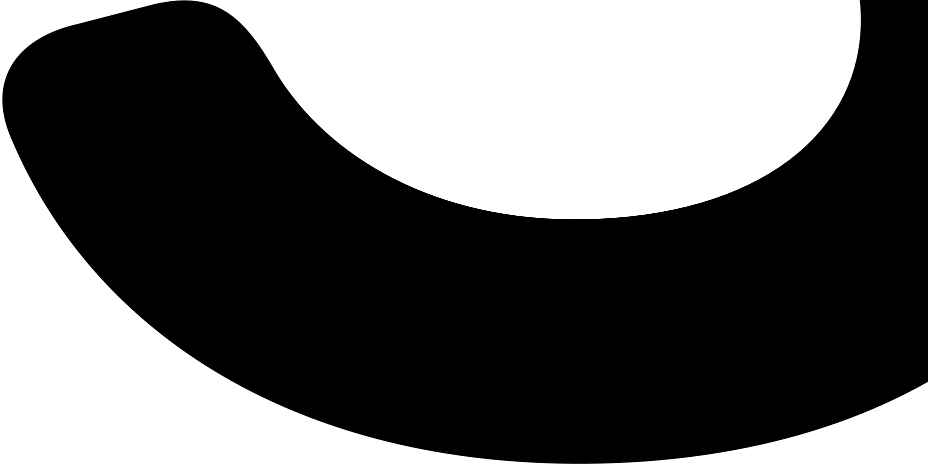


L

[redacted]







H

W

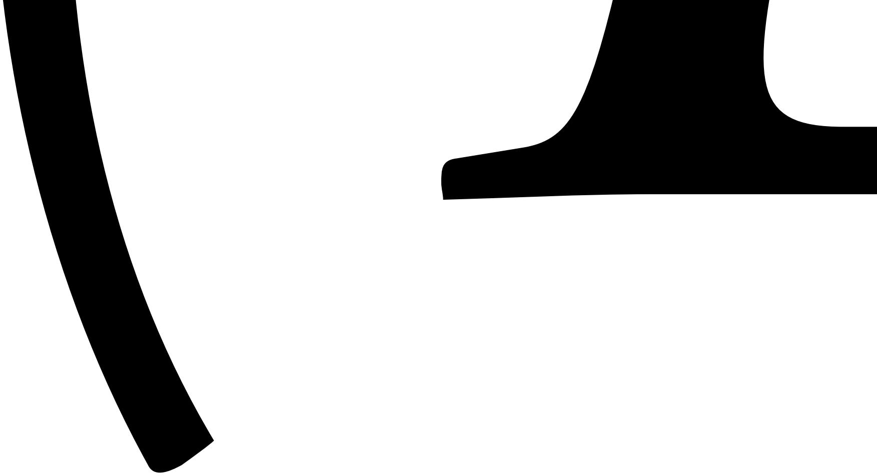
p

st

T

fr

a



T

O

N

C

a

S

S

T

p

p

p

g

p

g

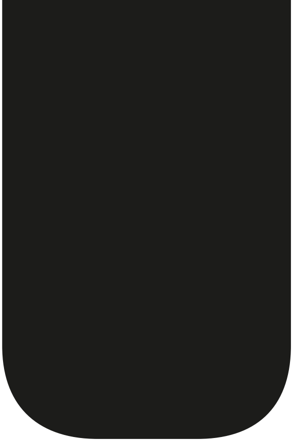
L

le

th

T

a

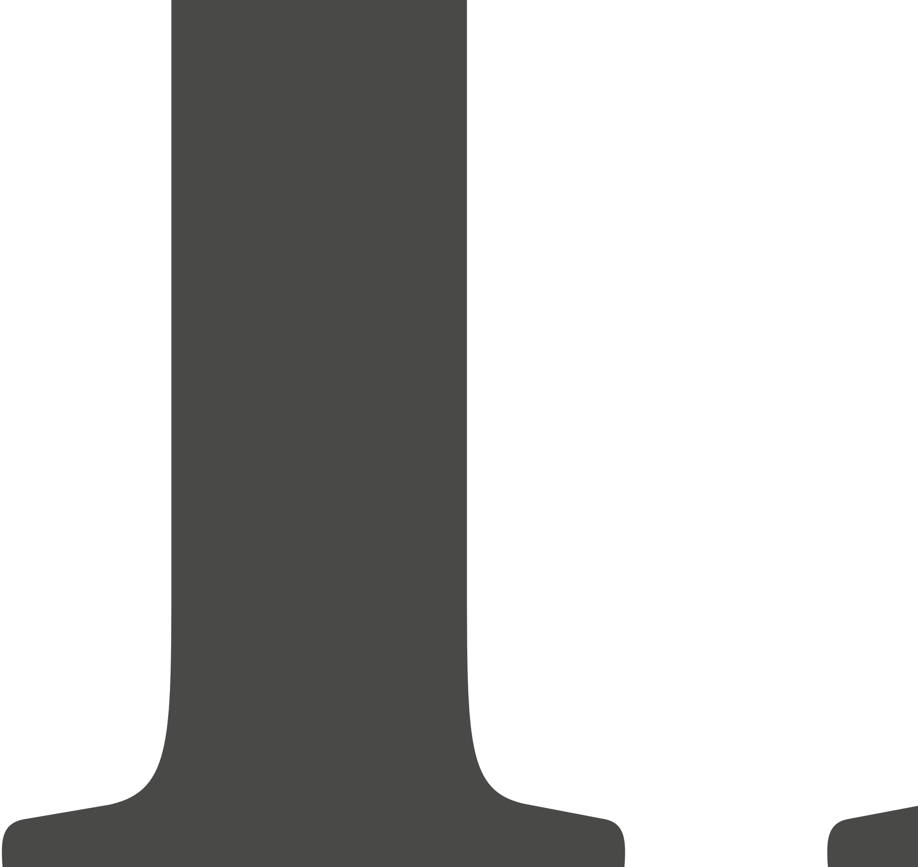


P

t

in

b

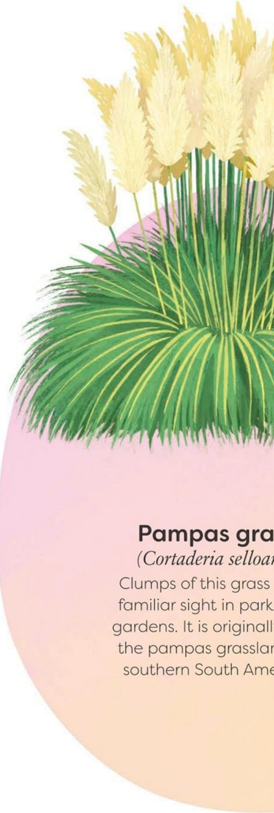


T

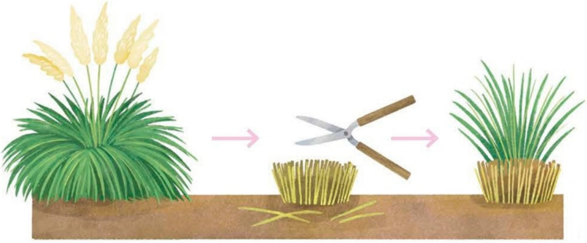
st

sp

Pampas grass



Pampas gra
(Cortaderia selloa
Clumps of this grass
familiar sight in park
gardens. It is originall
the pampas grasslar
southern South Ame



From the ground up

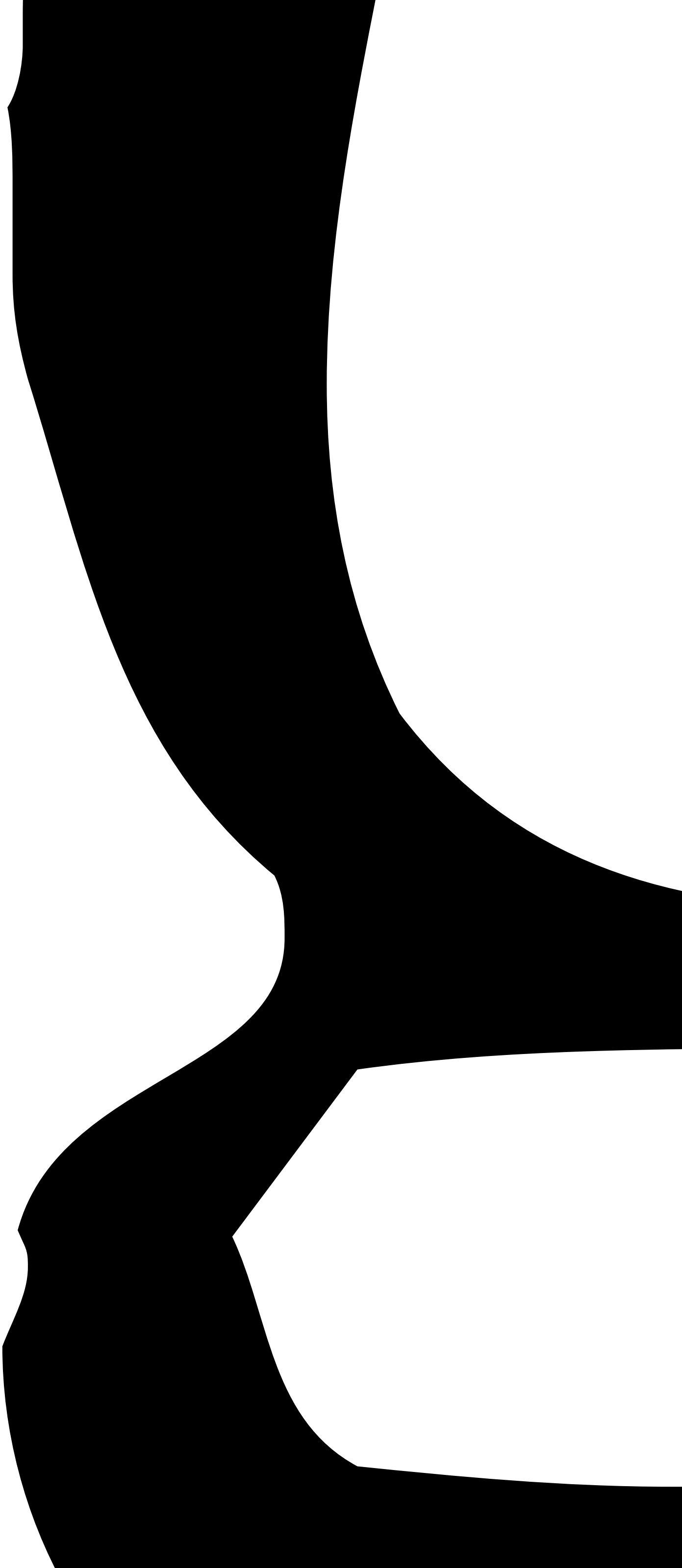
Unlike most plants, the growing
point of grass stems is at soil leve
not at the tip. Therefore, if a gra
cut, this does not kill it—it simply
keeps pushing up from the groun
This is why grassy lawns can be
mown regularly.

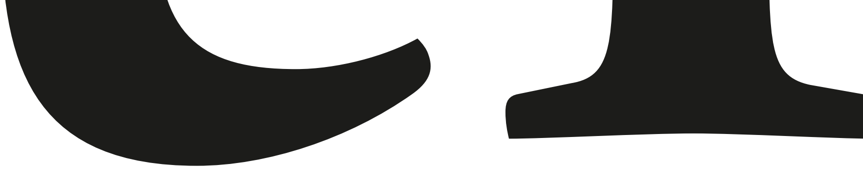
[redacted]

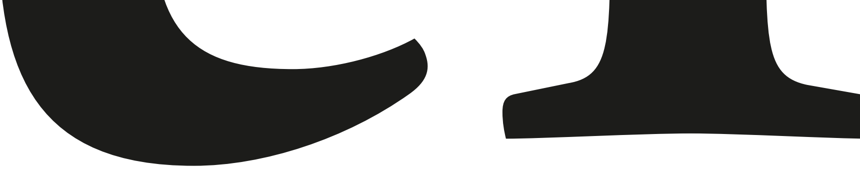
IV

[redacted]

G







U

p

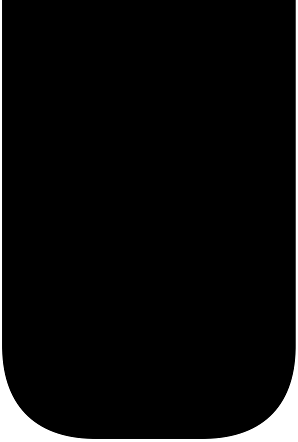
n

C

k

T

m



C

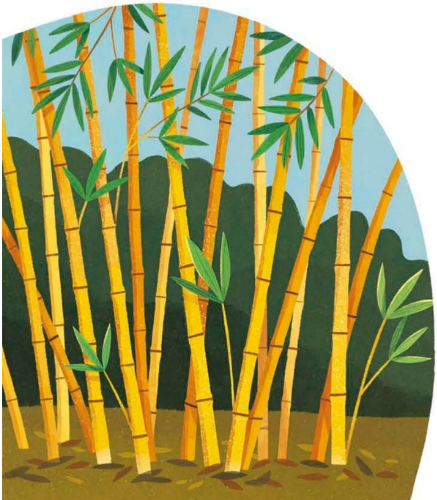
f

g

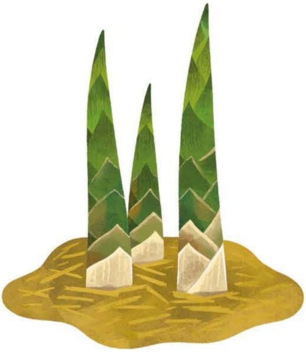
th

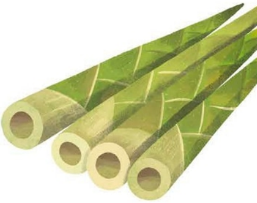
S

Bamboo

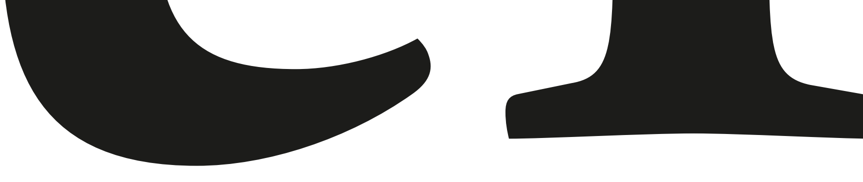


Giant timber bamboo
(Phyllostachys bambusoides)
In the wild, this bamboo lives in China. It is planted as a crop in several Asian countries.





Bamboo shoots
Part of a bamboo's stem is underground and runs sideways through the soil. Buds on this stem send up new shoots, which look like small spears. The young shoots of some bamboo species are picked as a vegetable, but they must be cooked to make them edible.



P

u

th

Se

sr

S

a

C

l

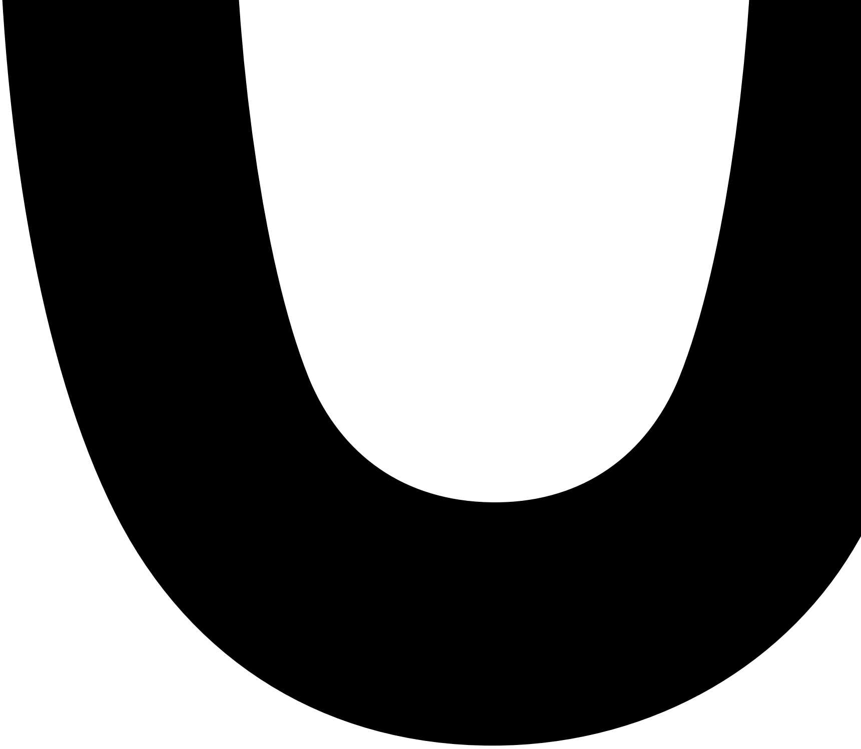
in

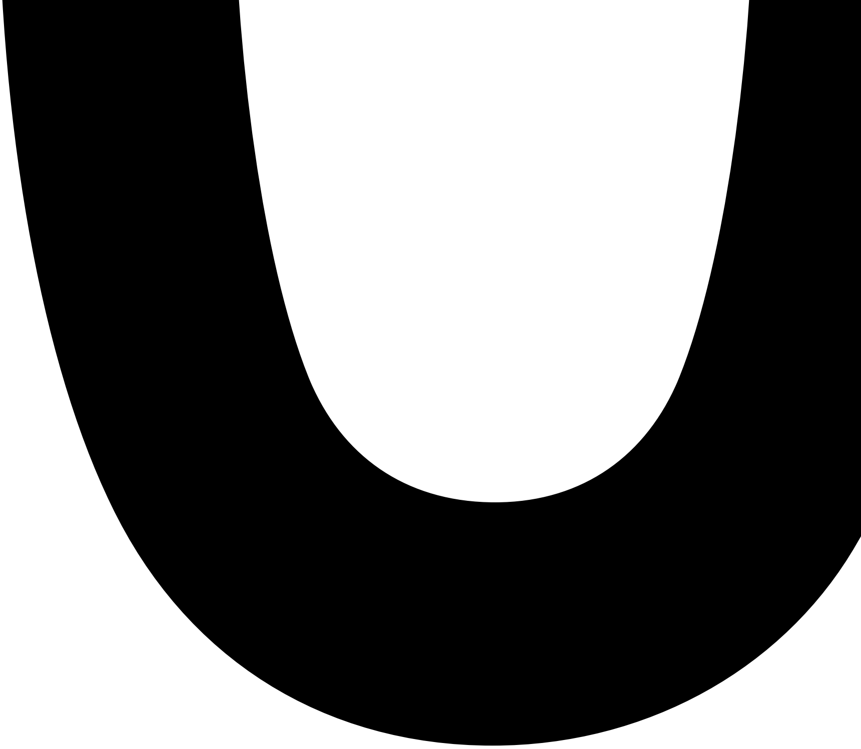
in

G

E

IV





T

b

U

U

W

T

re

a

W

B

h

g

B

le

W

iS

st

t

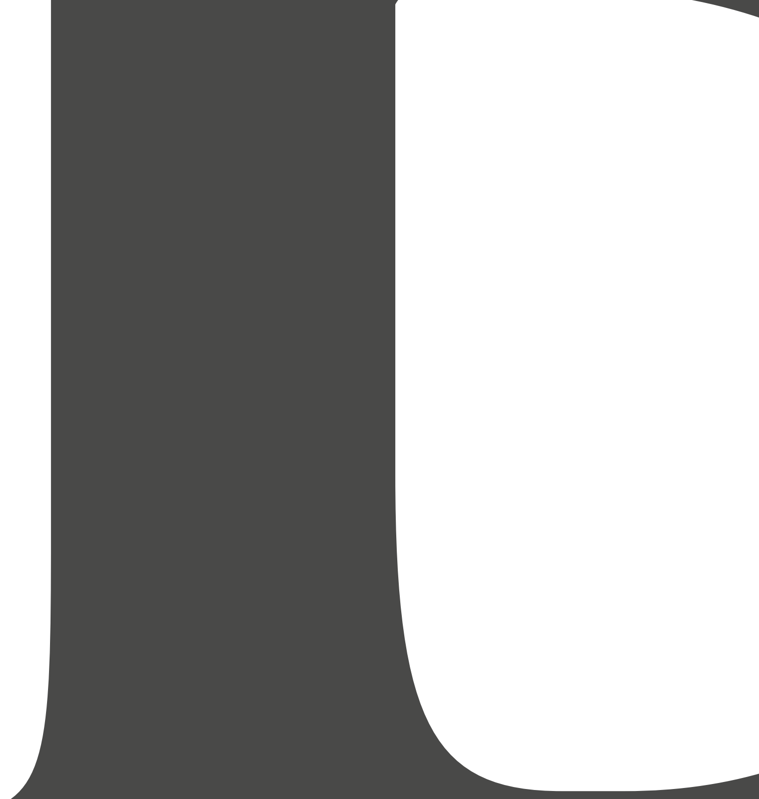
G

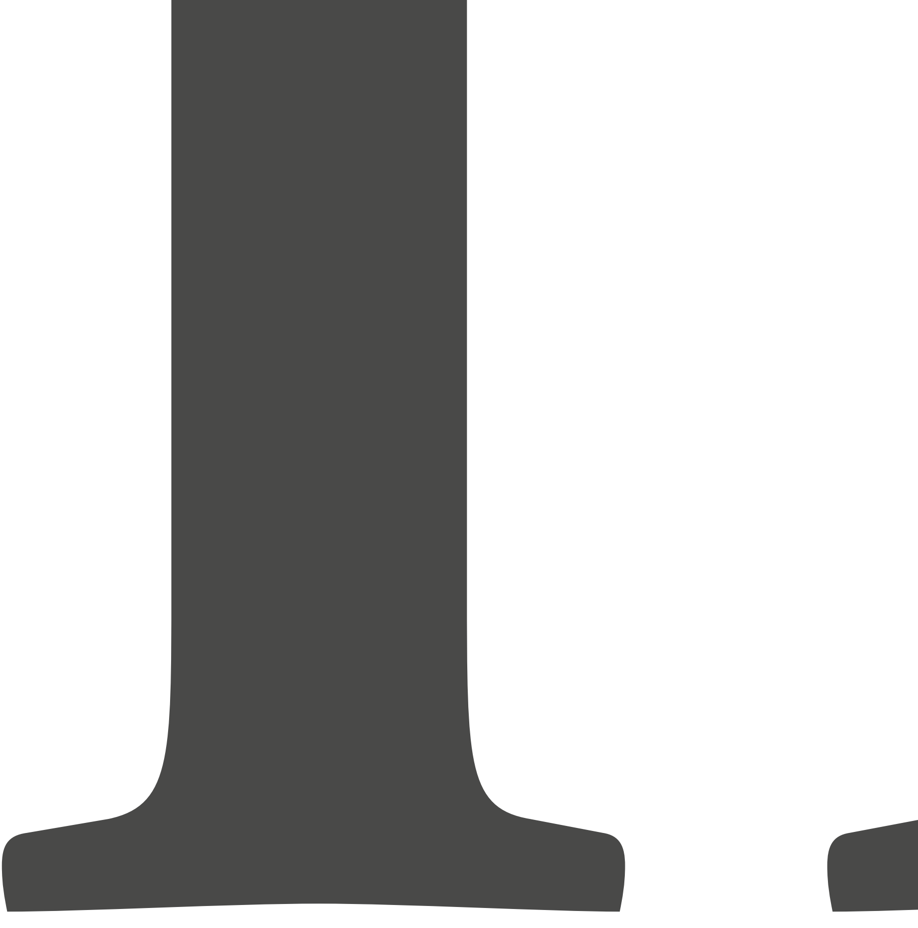
m

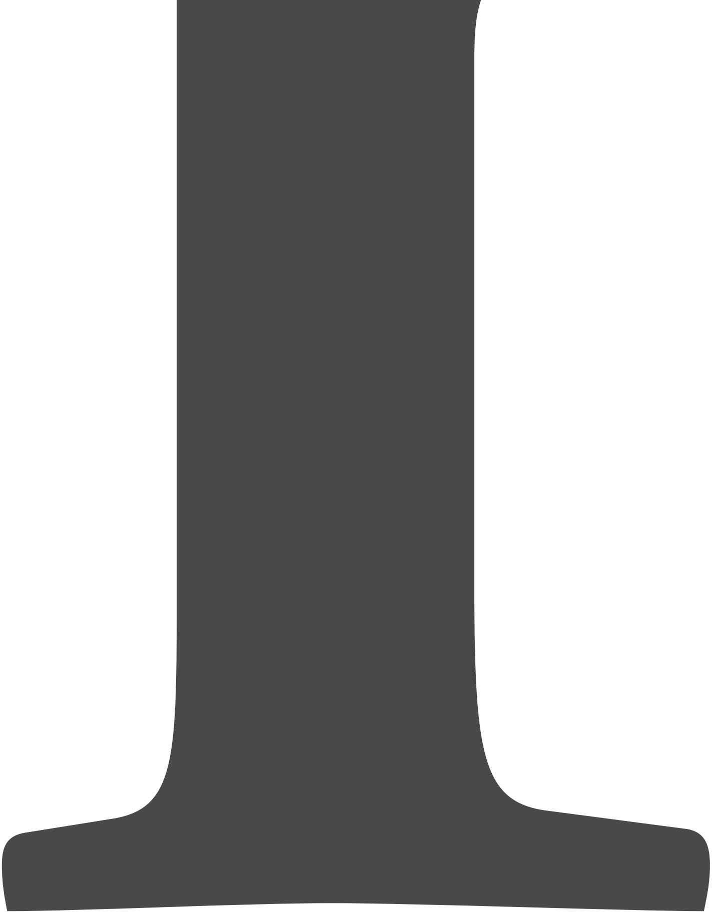
h

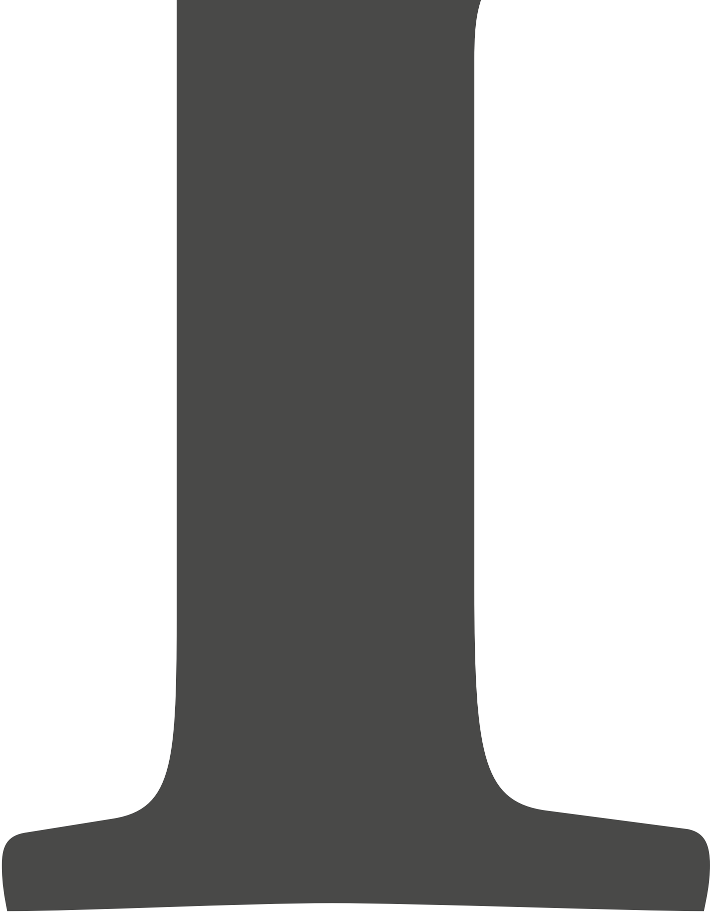
fr

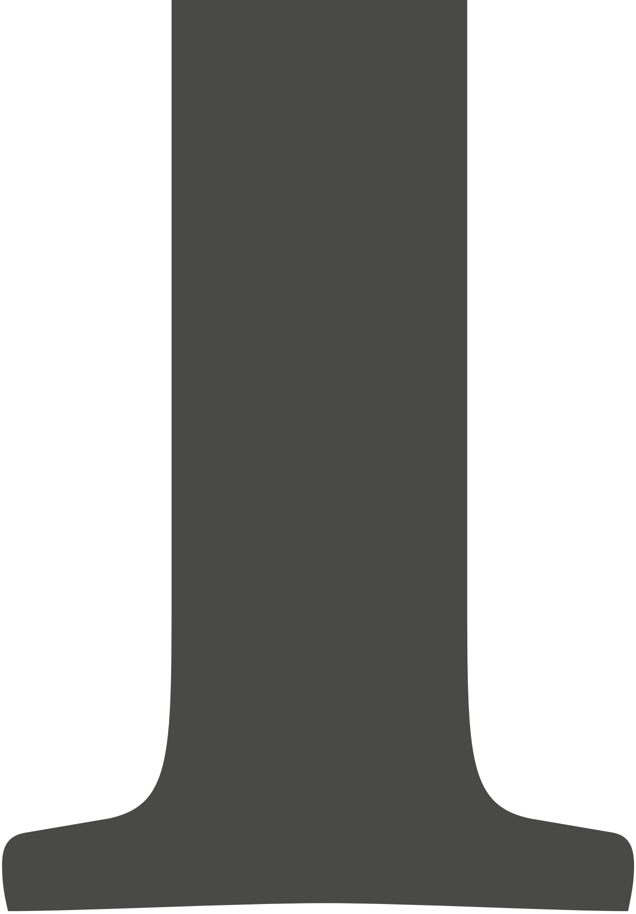
st



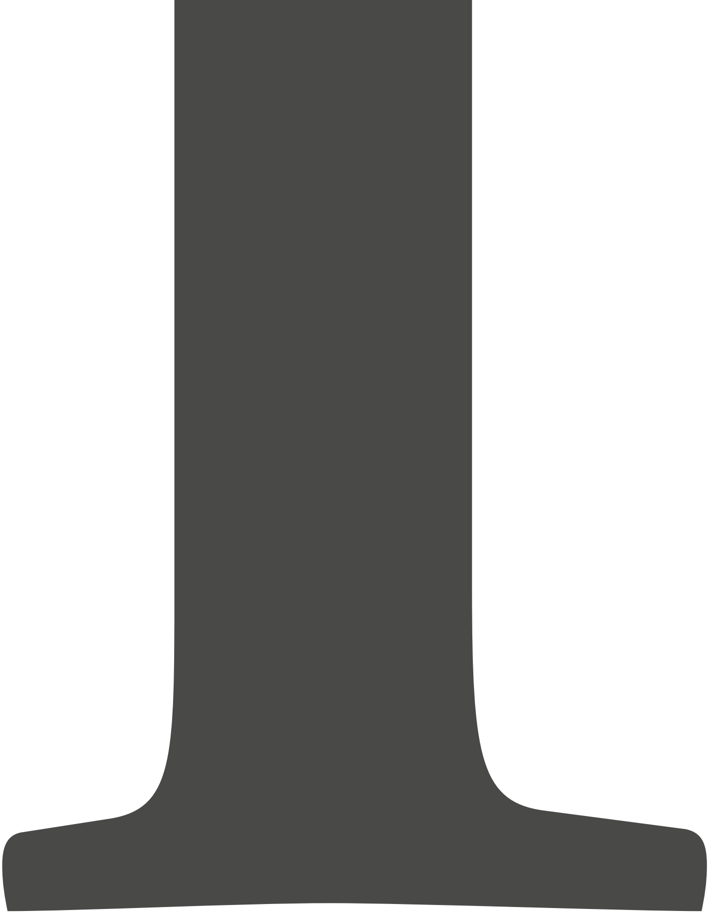


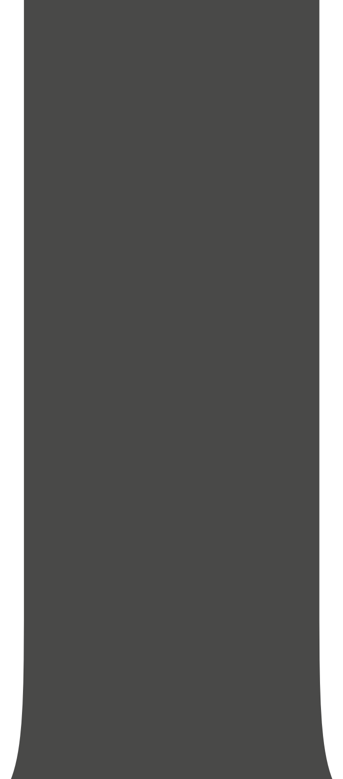




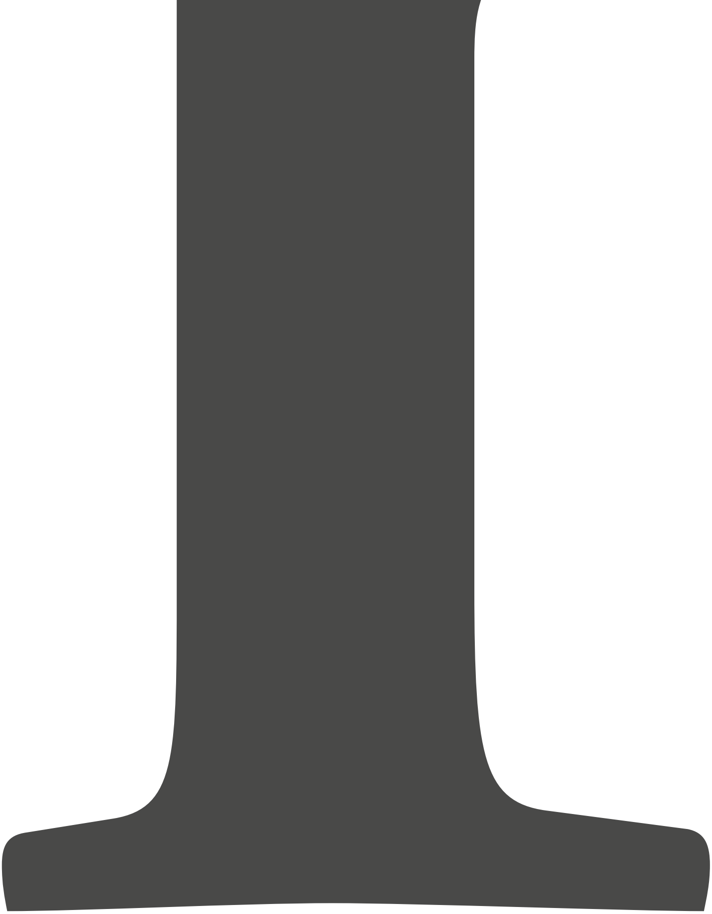


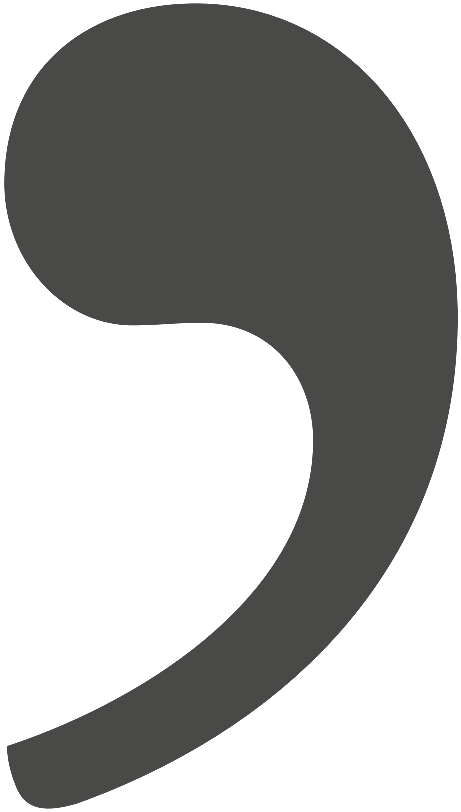
y

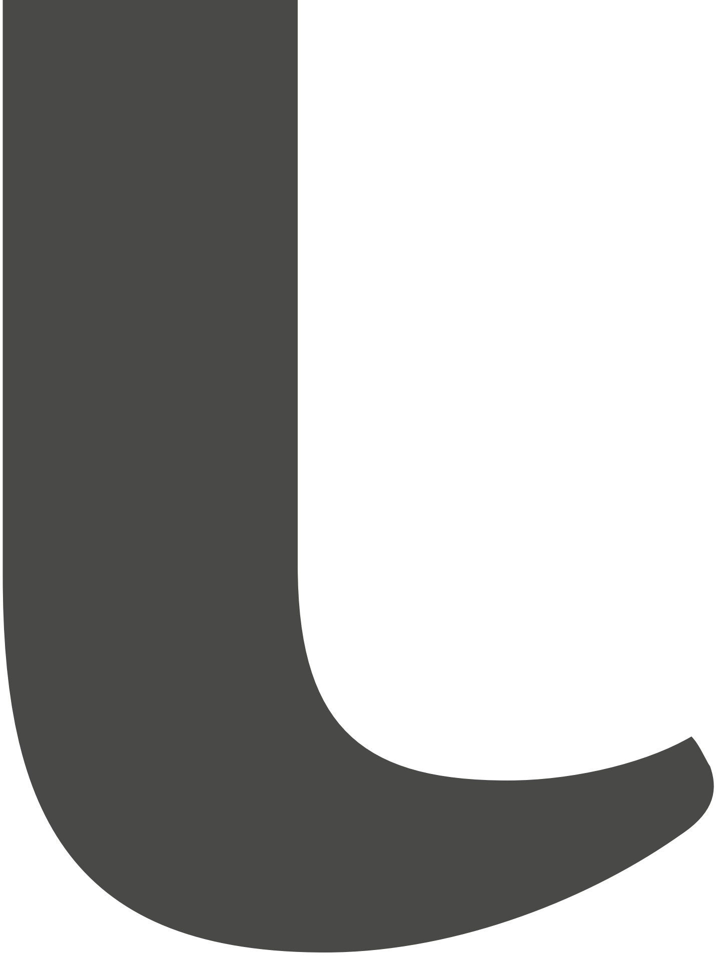




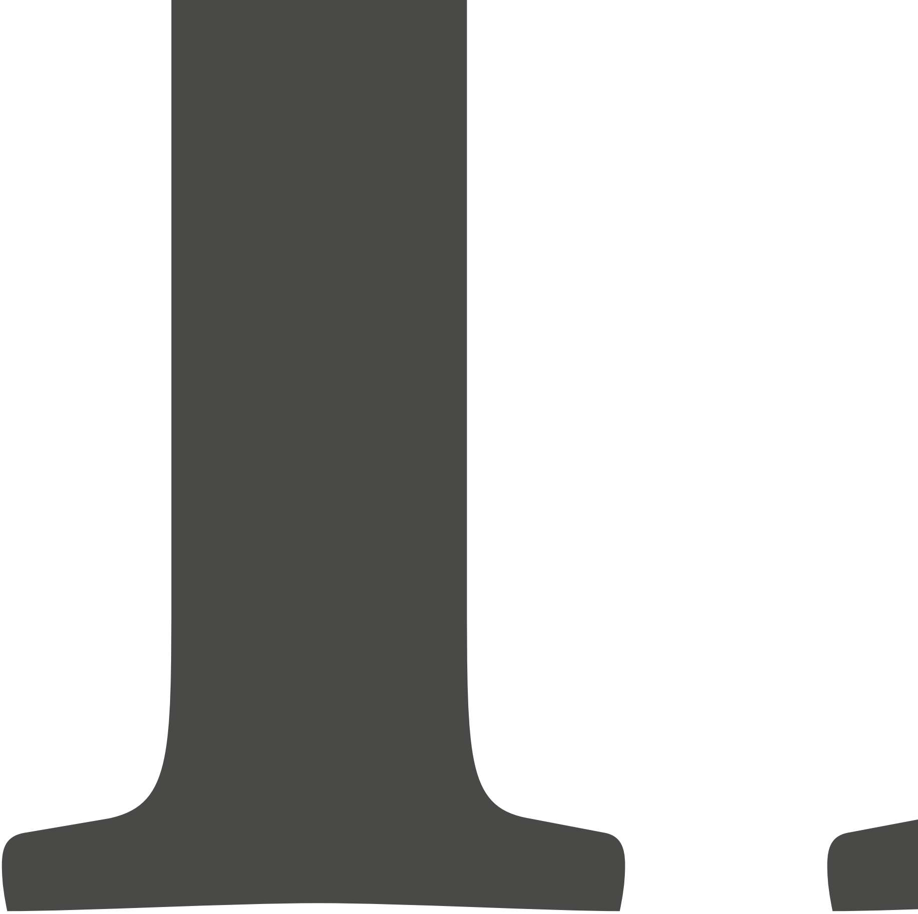
V

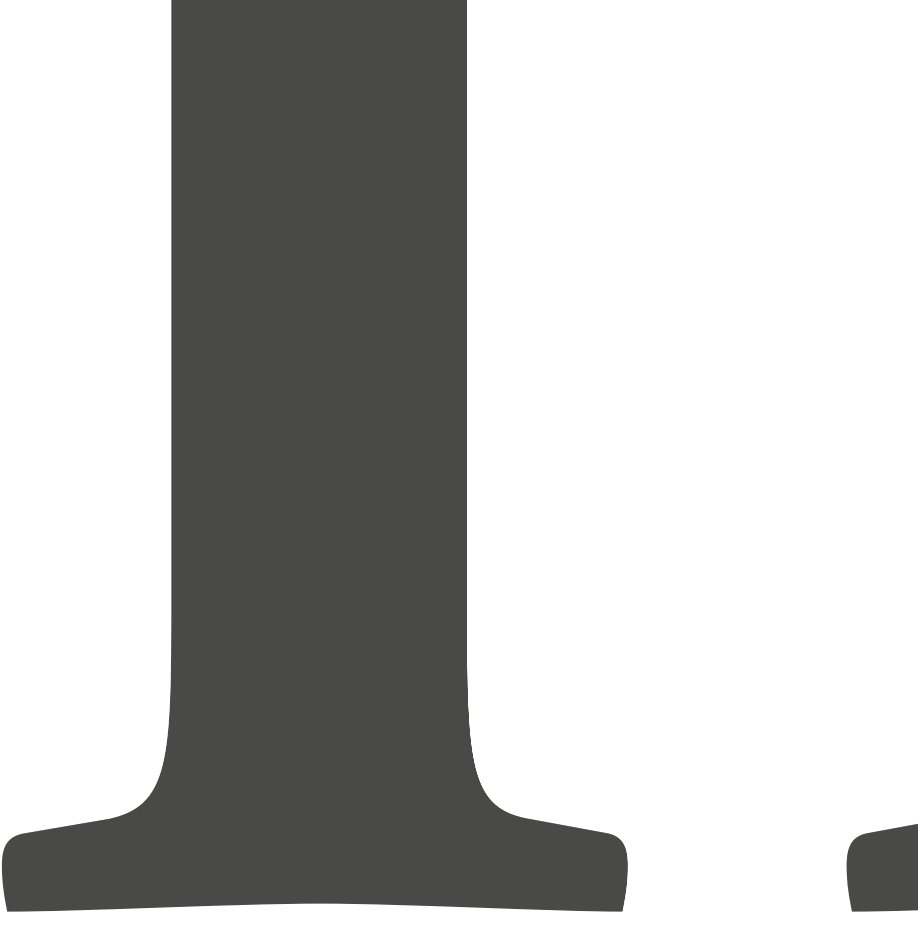


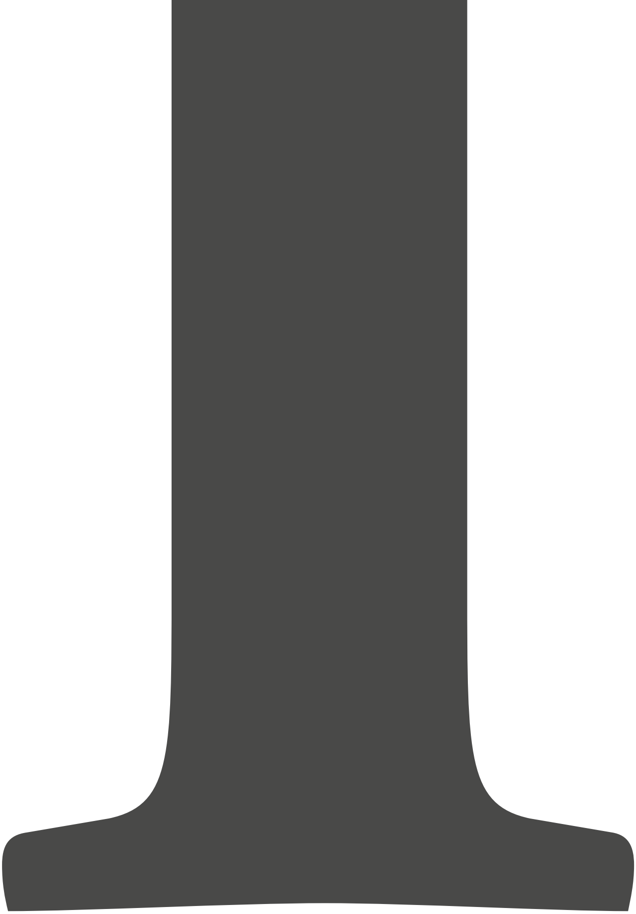


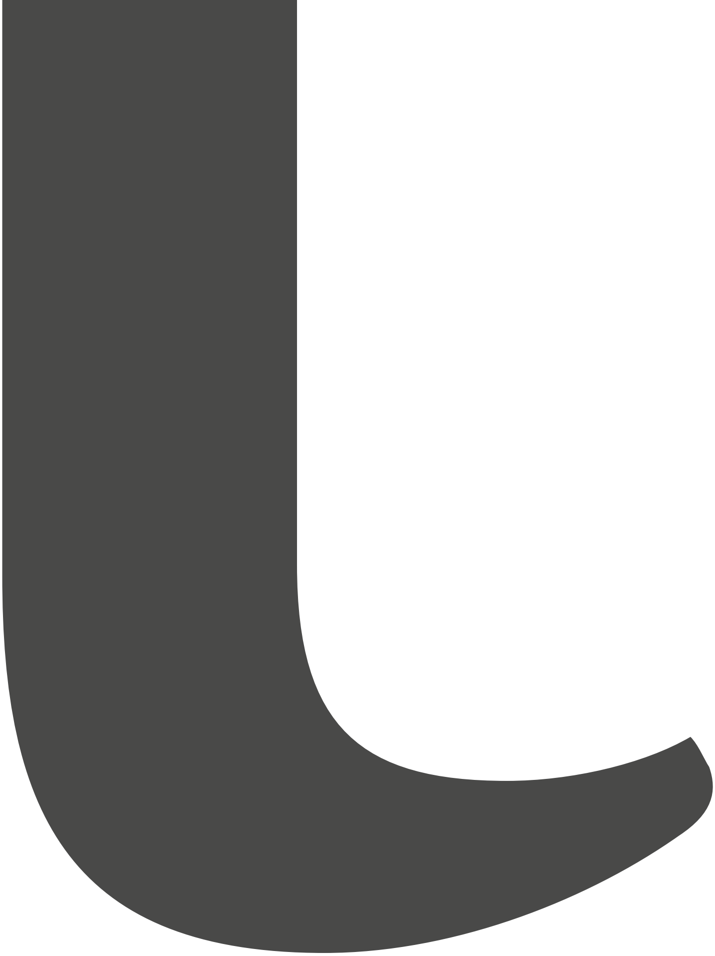


V

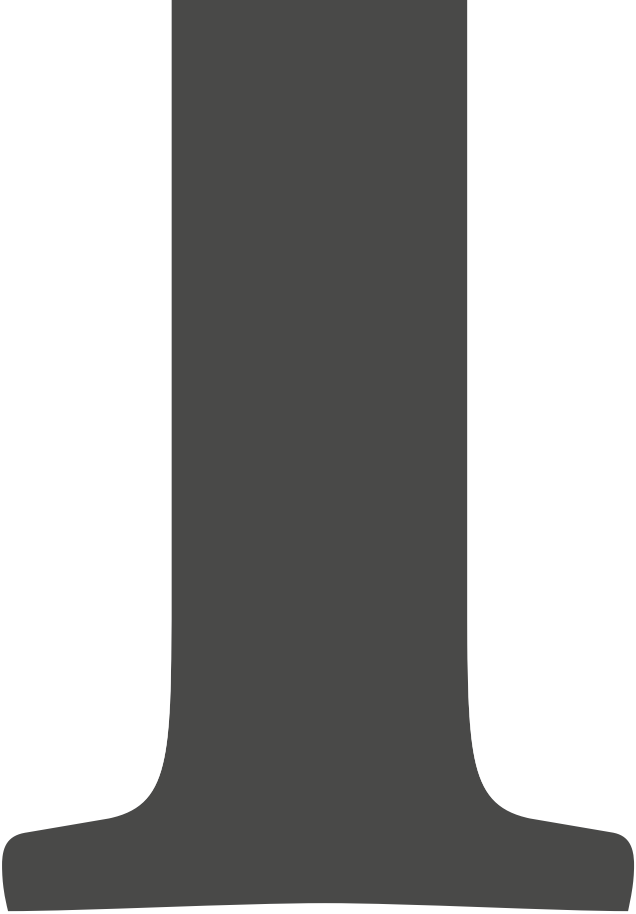


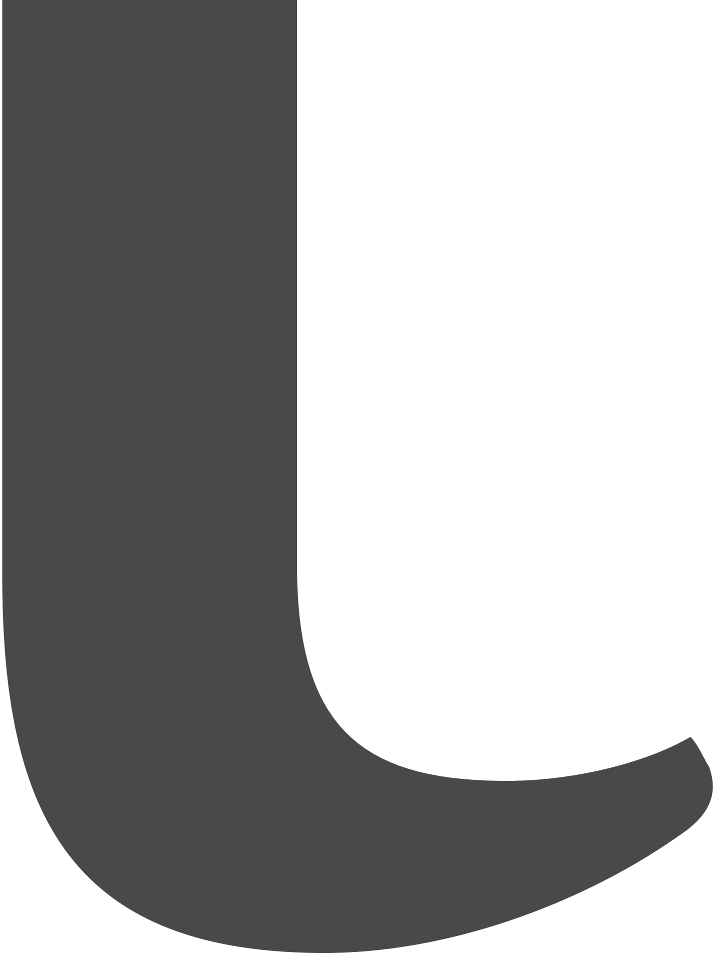




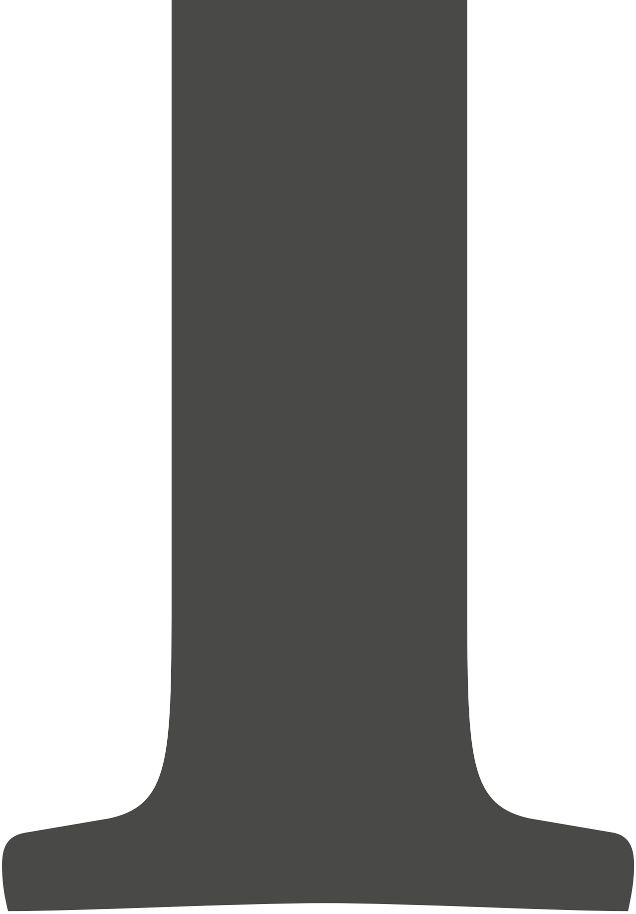


,



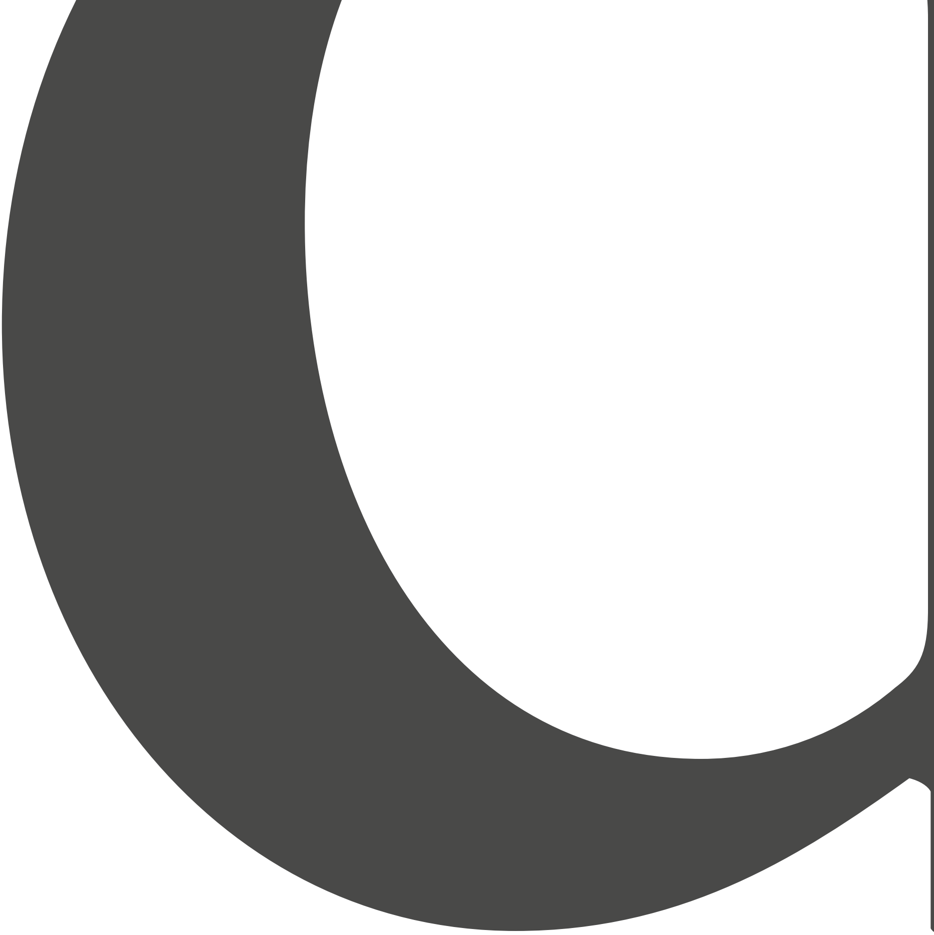


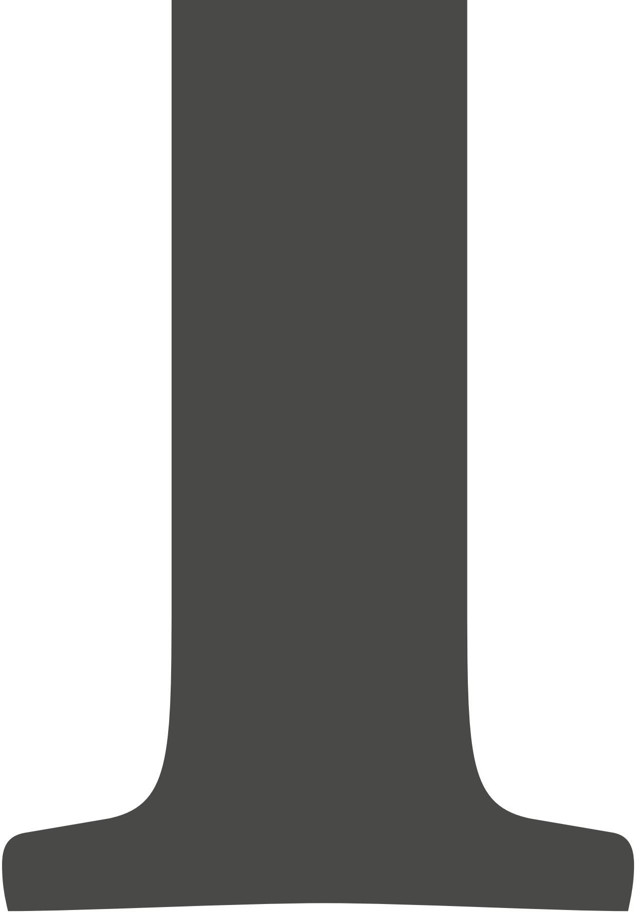
S



1

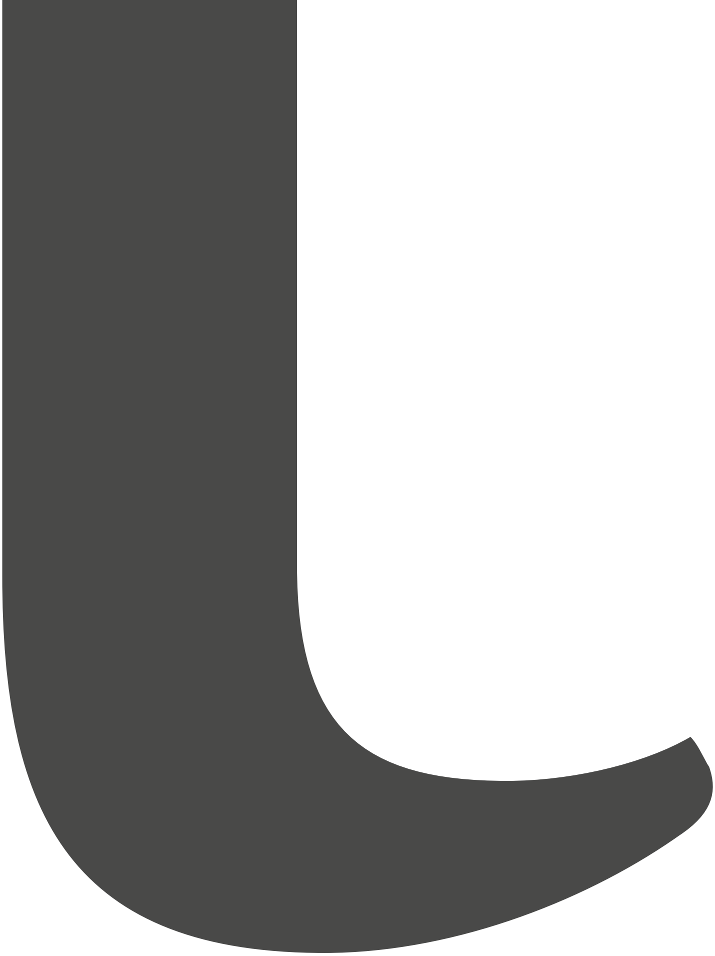
y

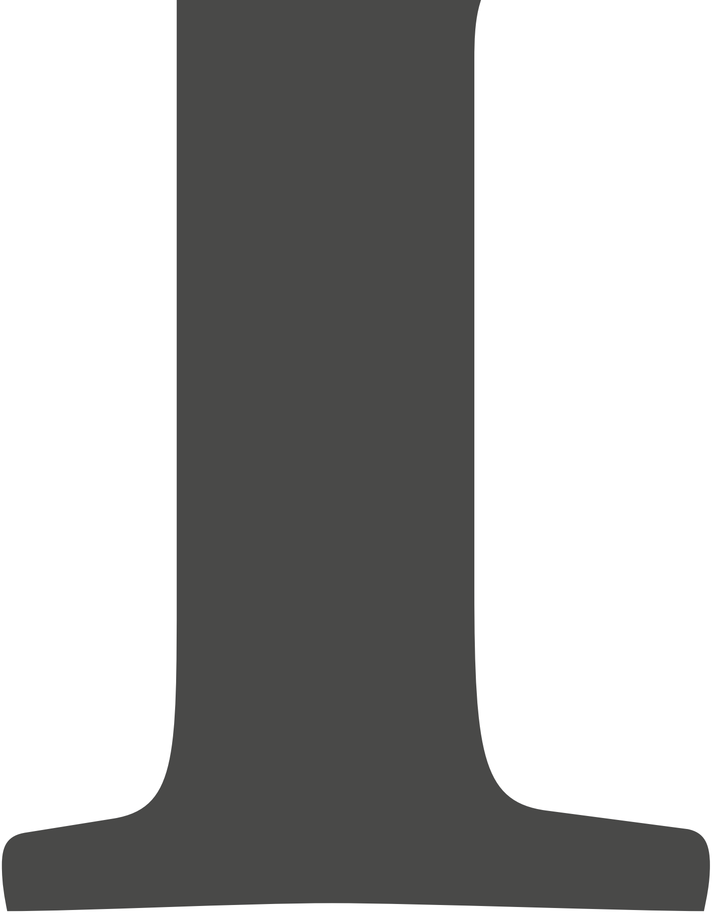




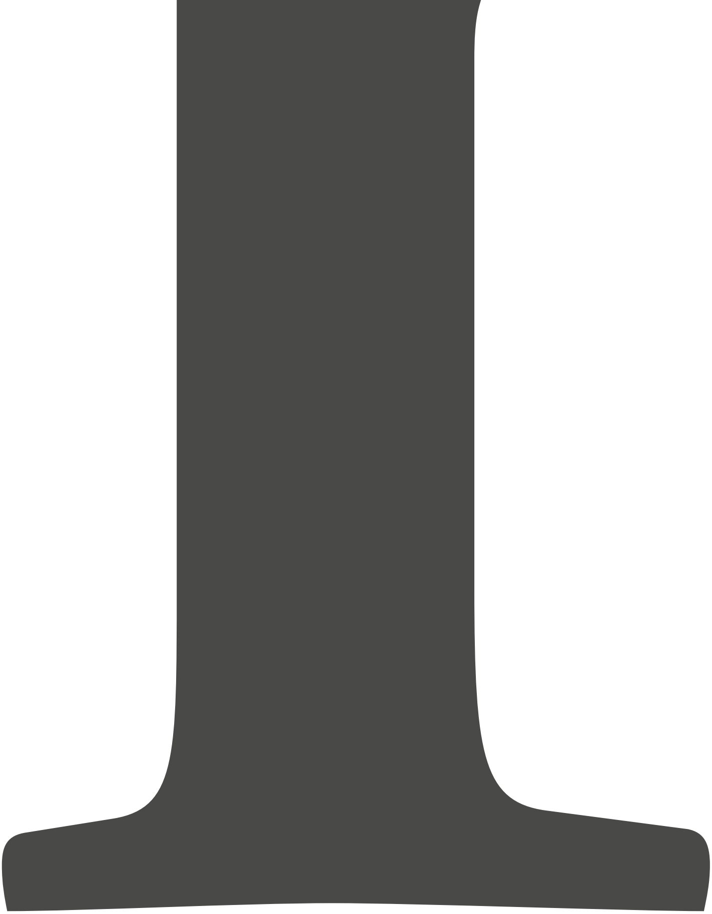
S

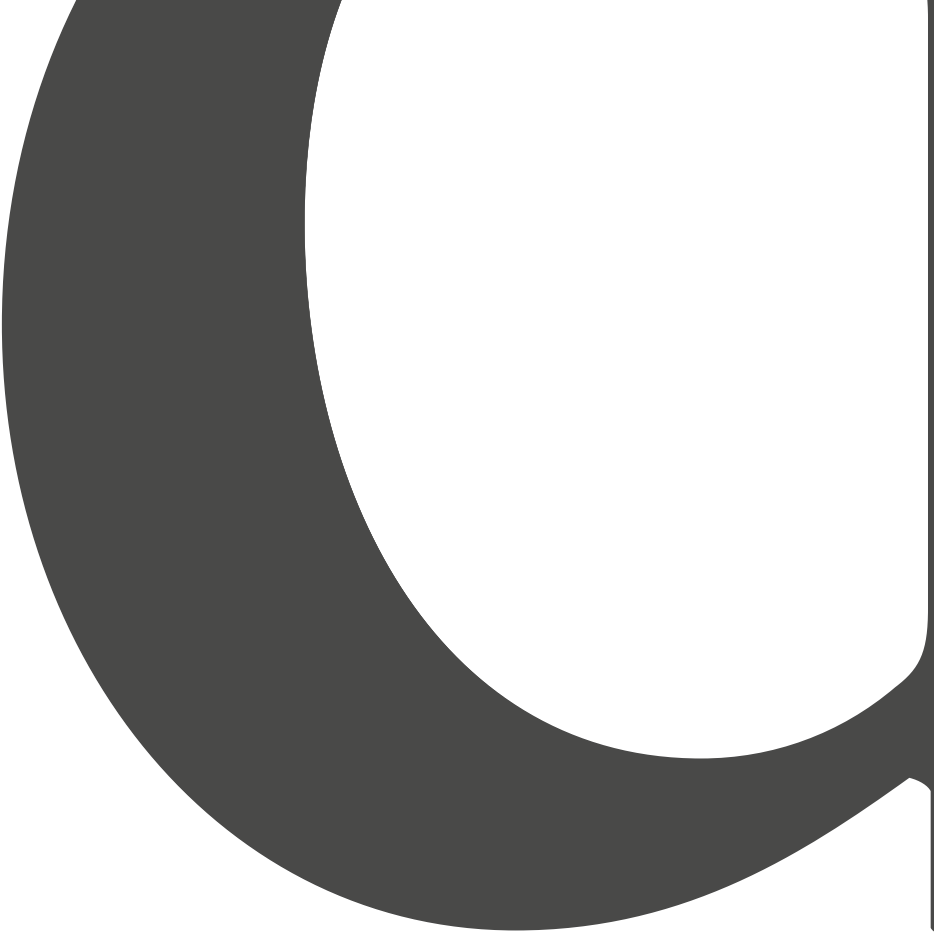
1

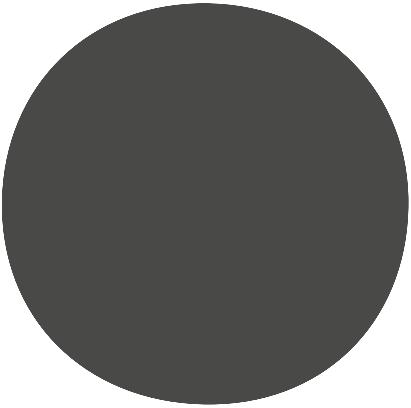




V





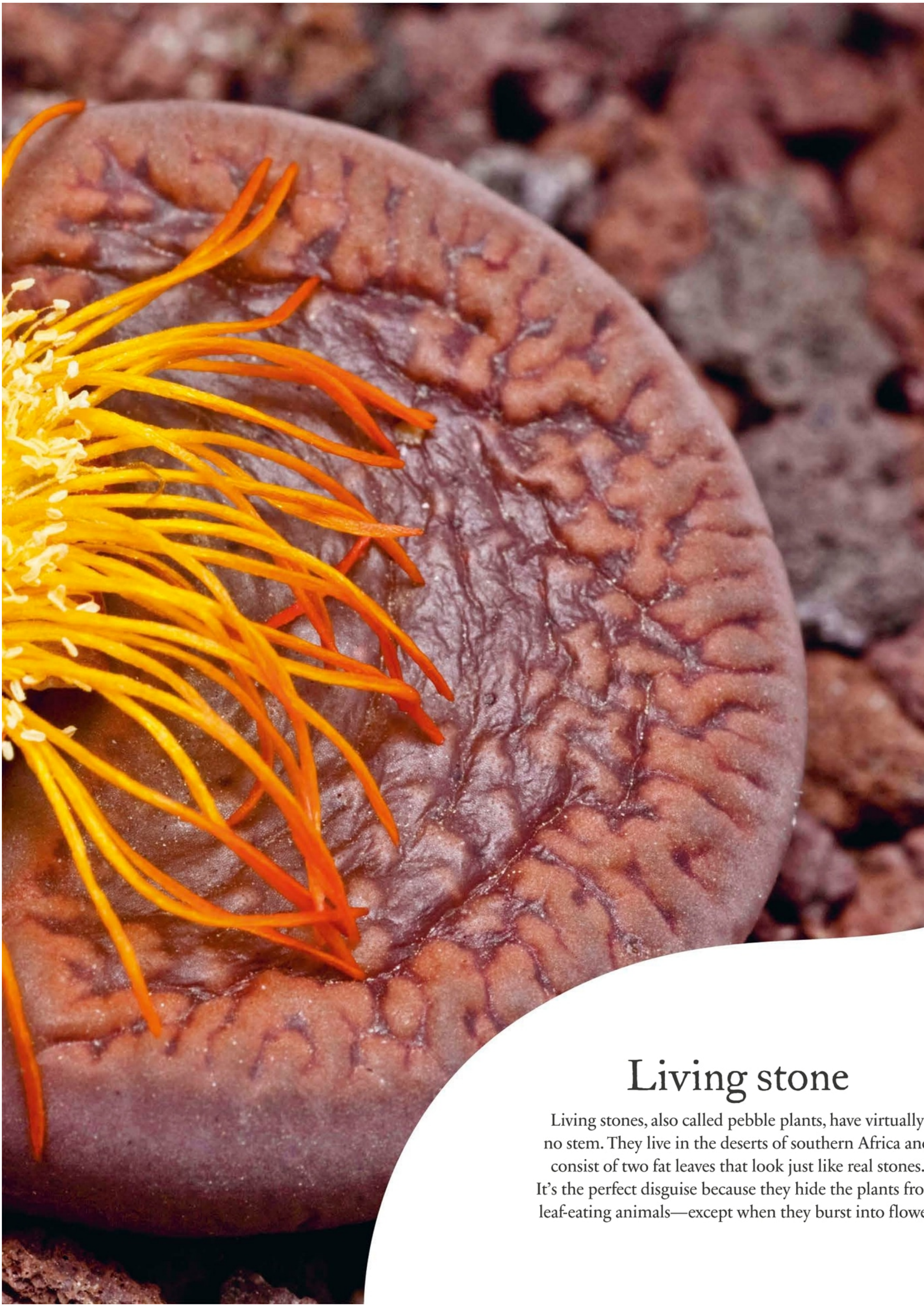


S

b

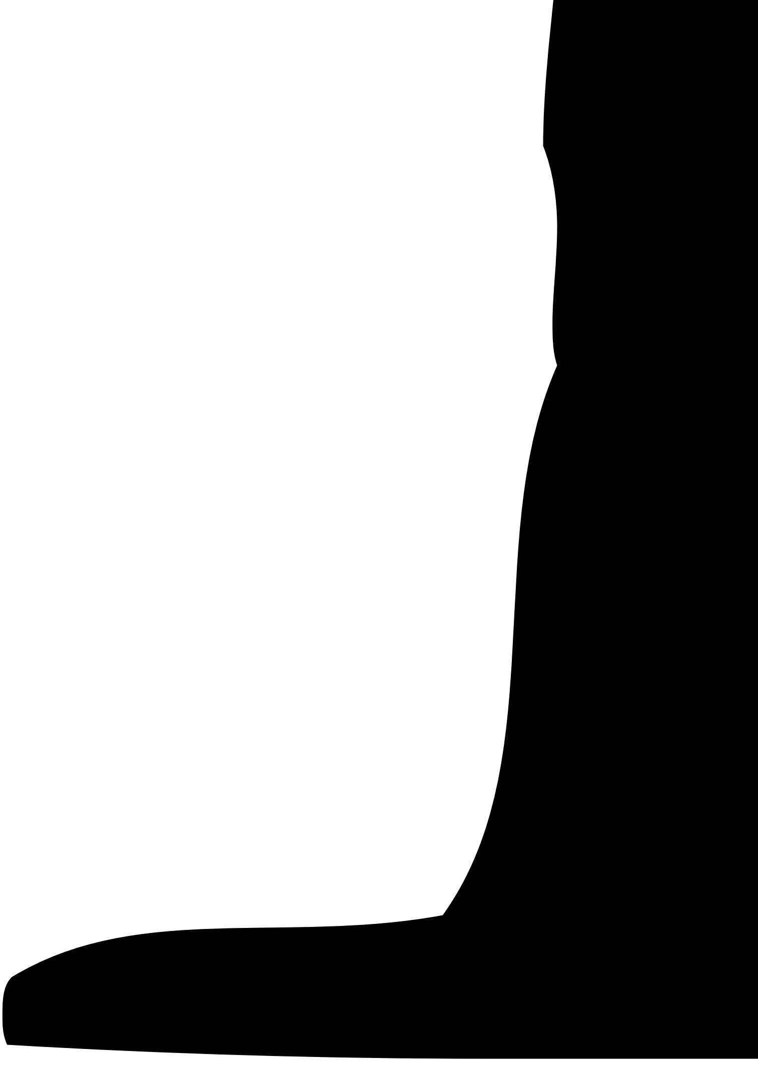
a

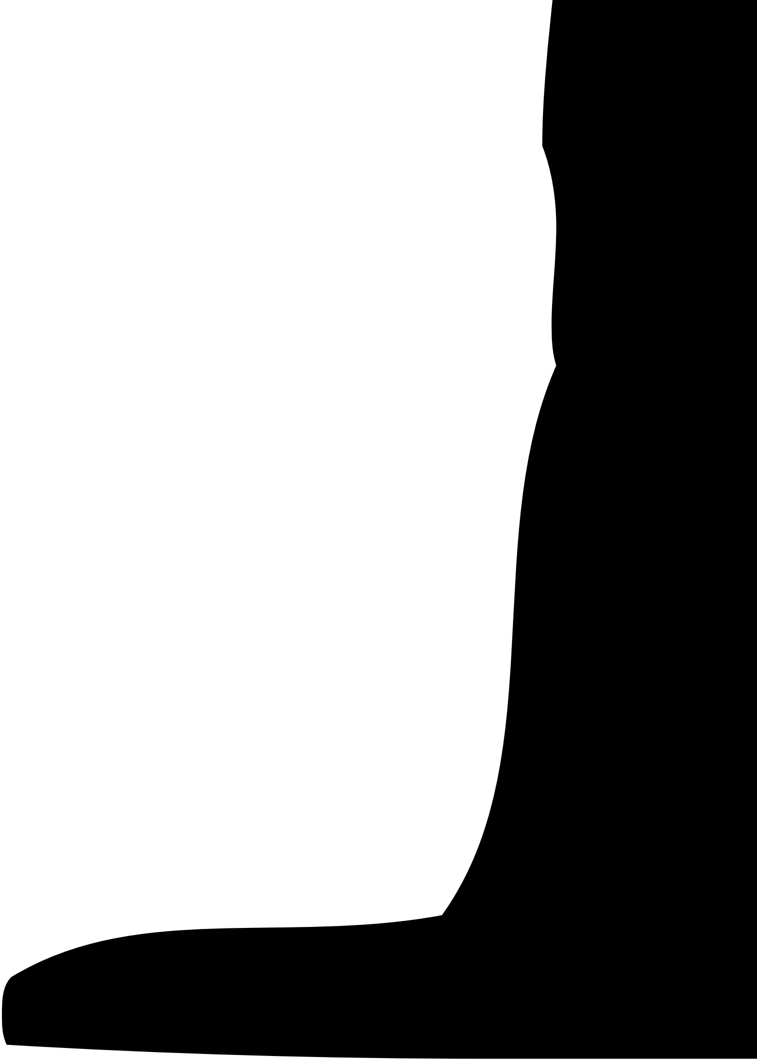
th

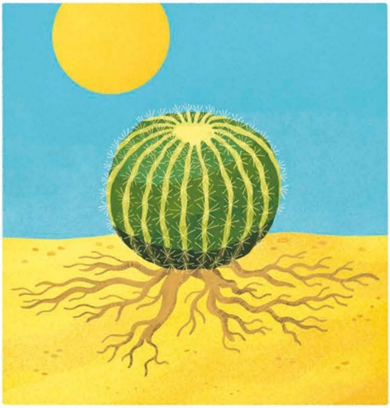


Living stone

Living stones, also called pebble plants, have virtually no stem. They live in the deserts of southern Africa and consist of two fat leaves that look just like real stones. It's the perfect disguise because they hide the plants fro leaf-eating animals—except when they burst into flowe

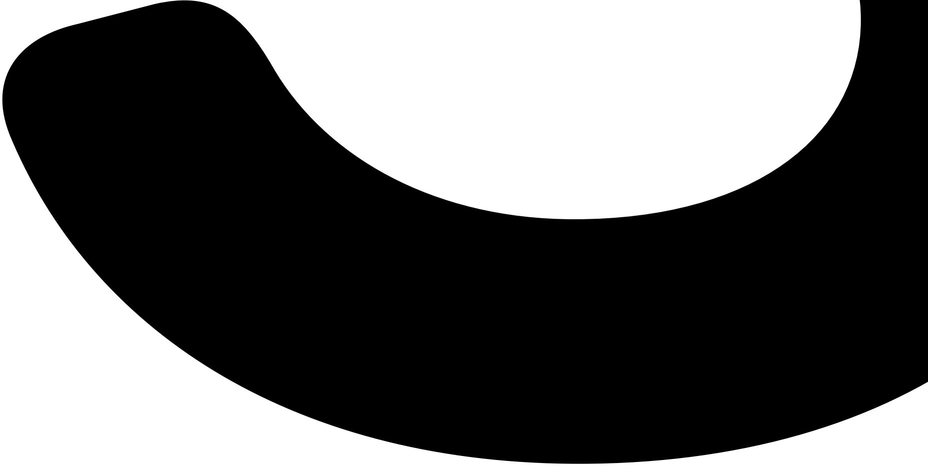






Shallow roots

The roots of the barrel cactus grow near the surface and reach outward a long way from the plant to soak up precious rain and dew as fast as possible. Fine hairs on the roots help them absorb water.



T

SU

th

a

h

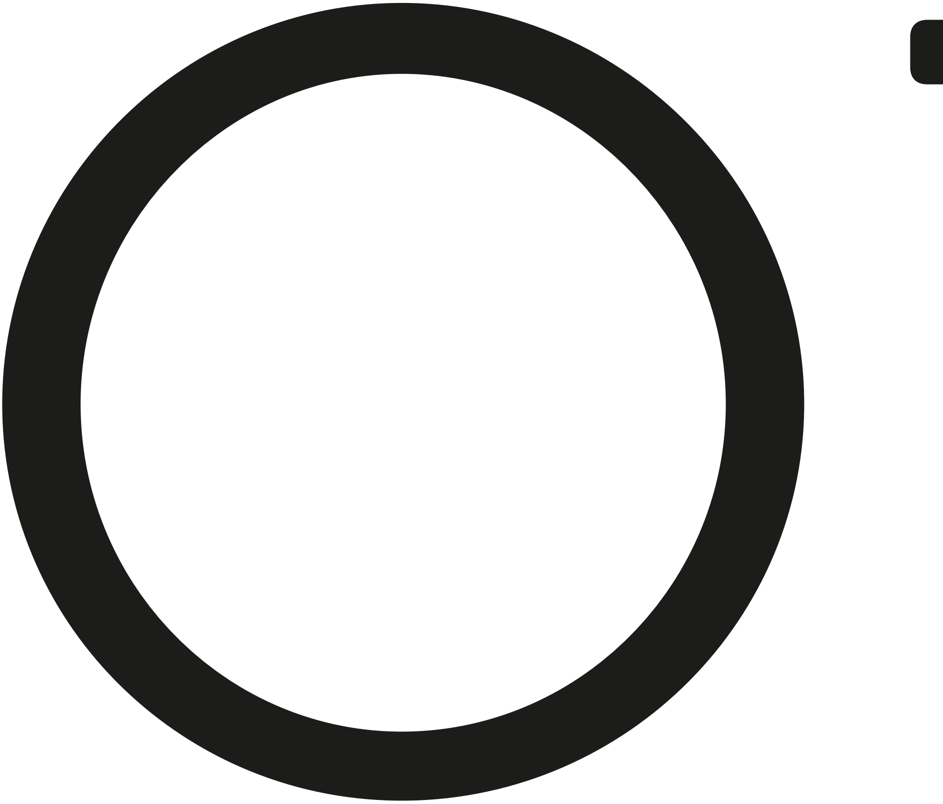
T

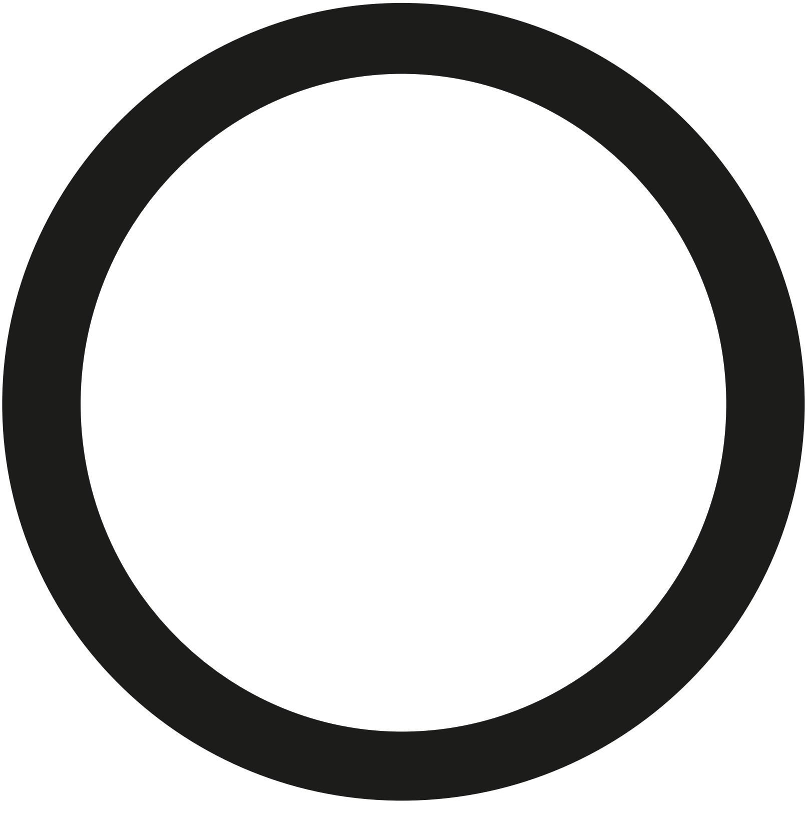
in

W

th

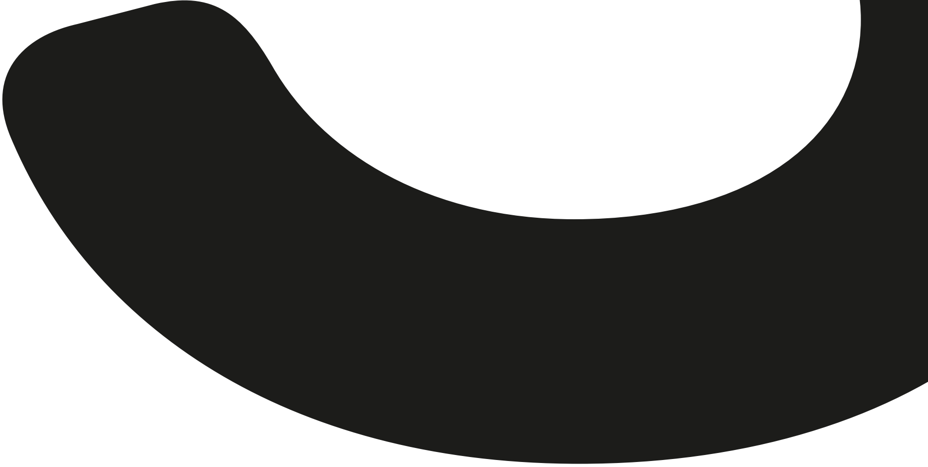
A





fl

fi



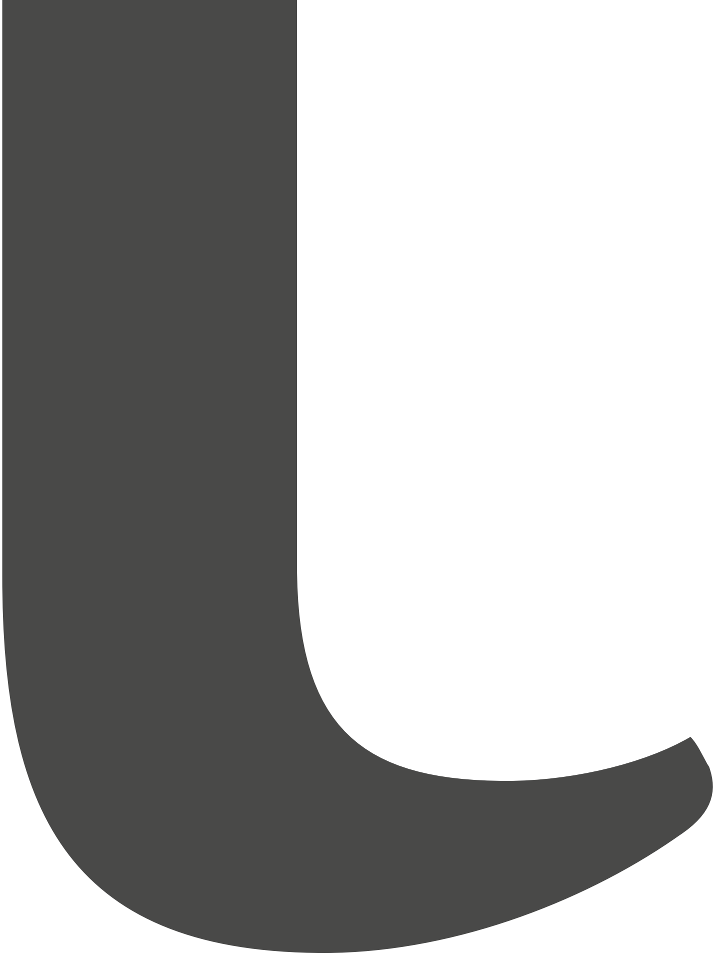
l

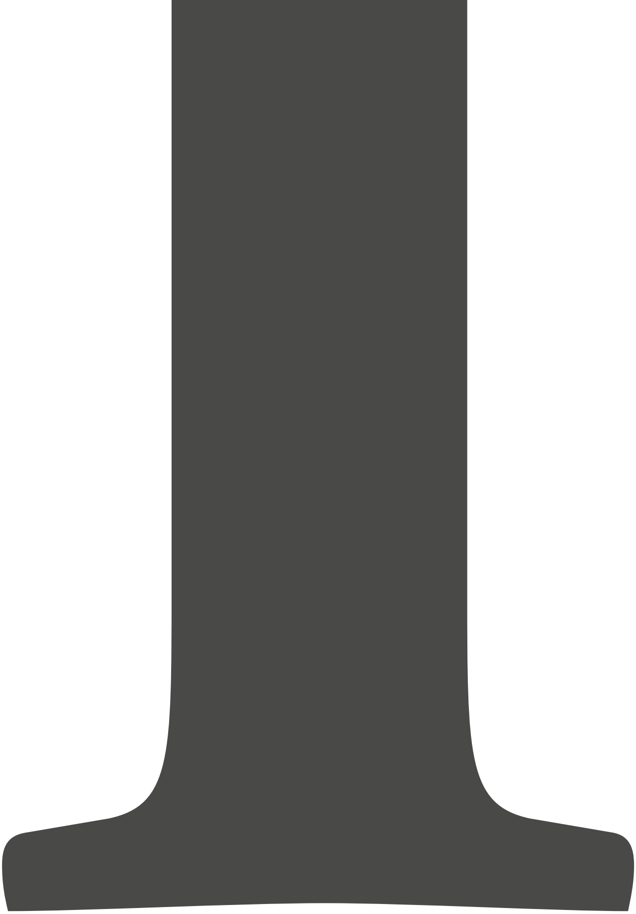
th

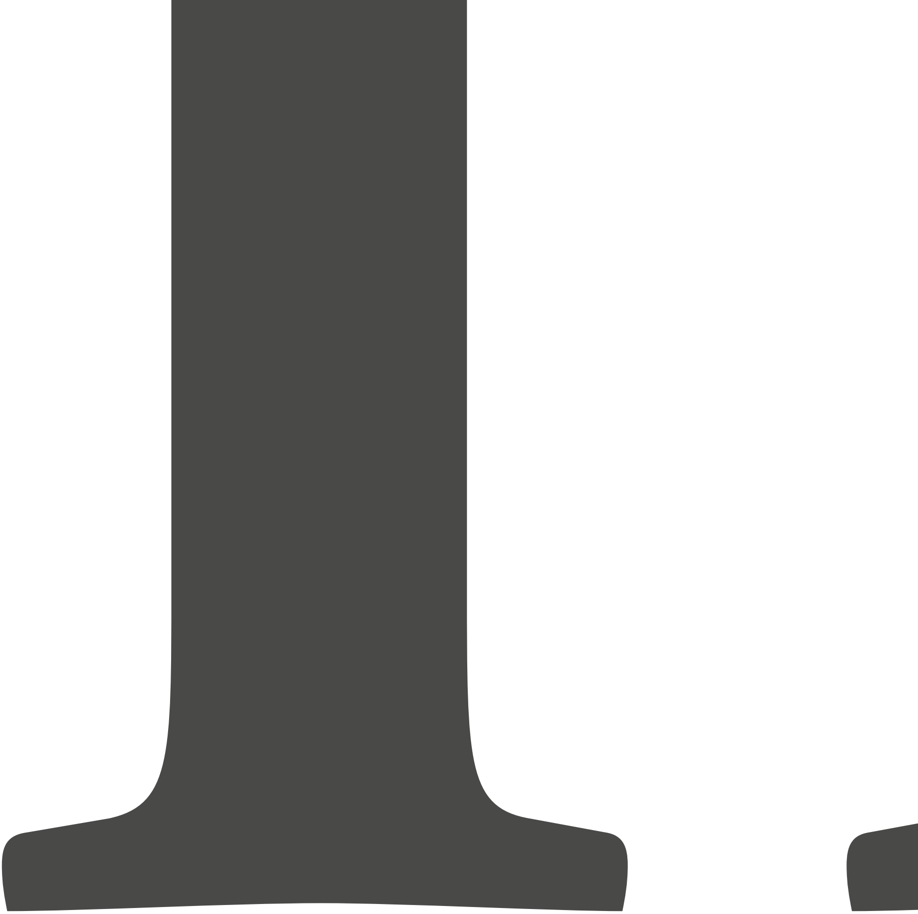
W

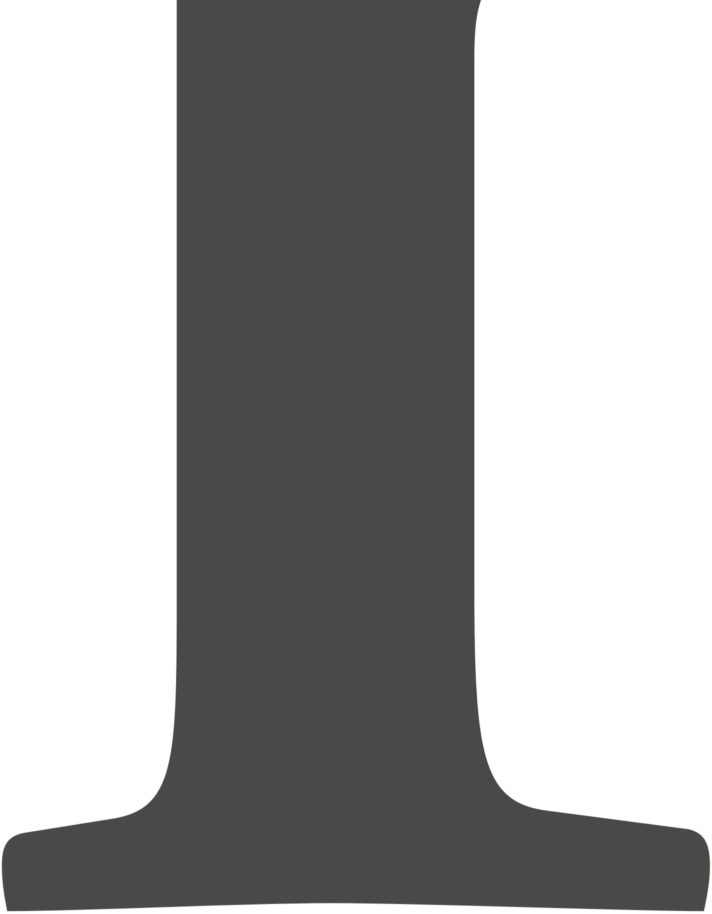
C

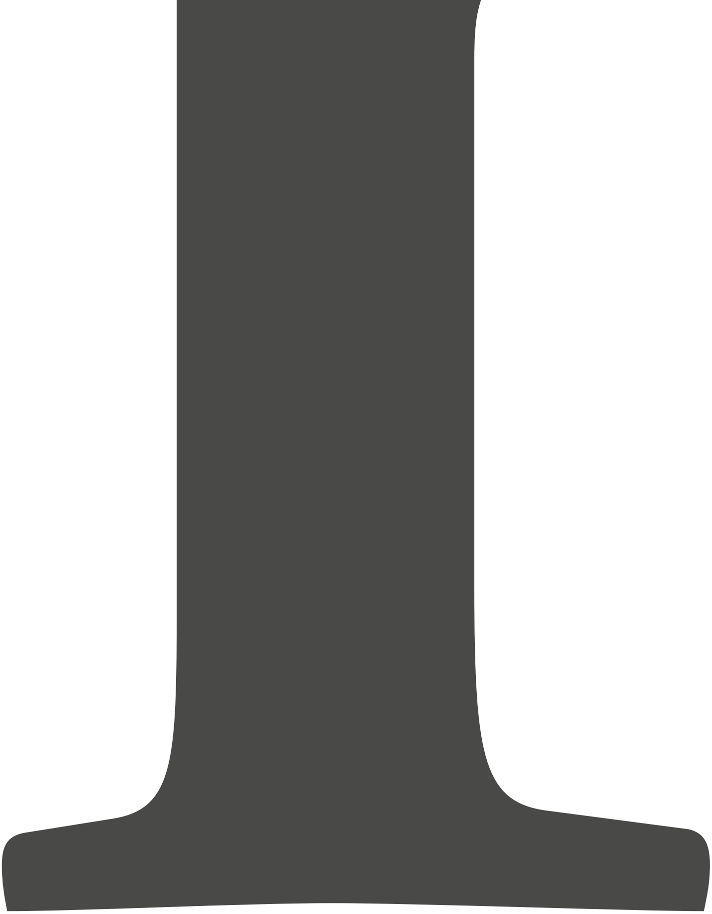
sh



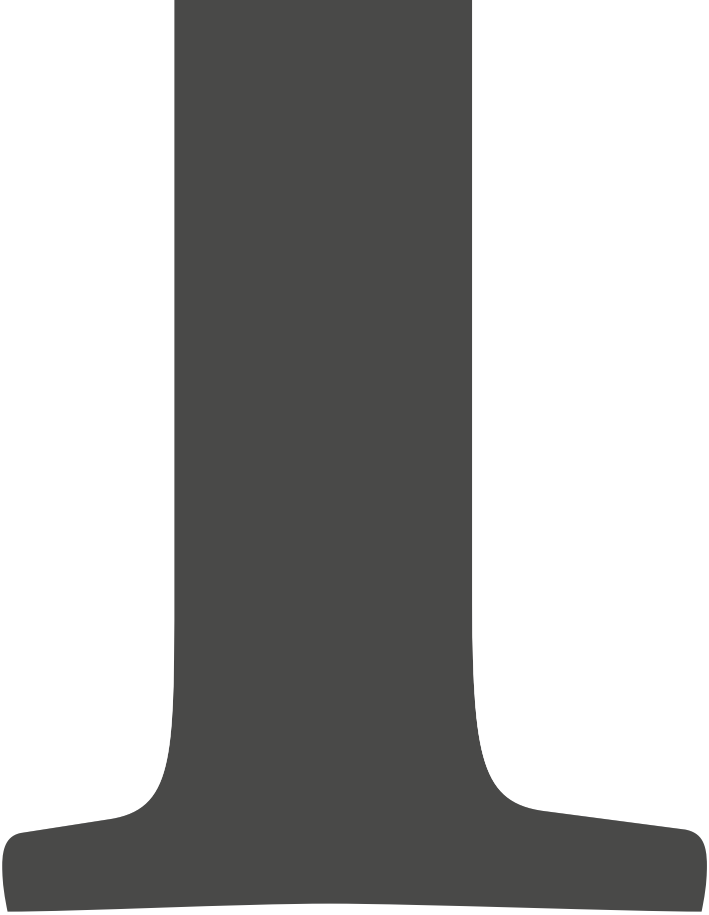


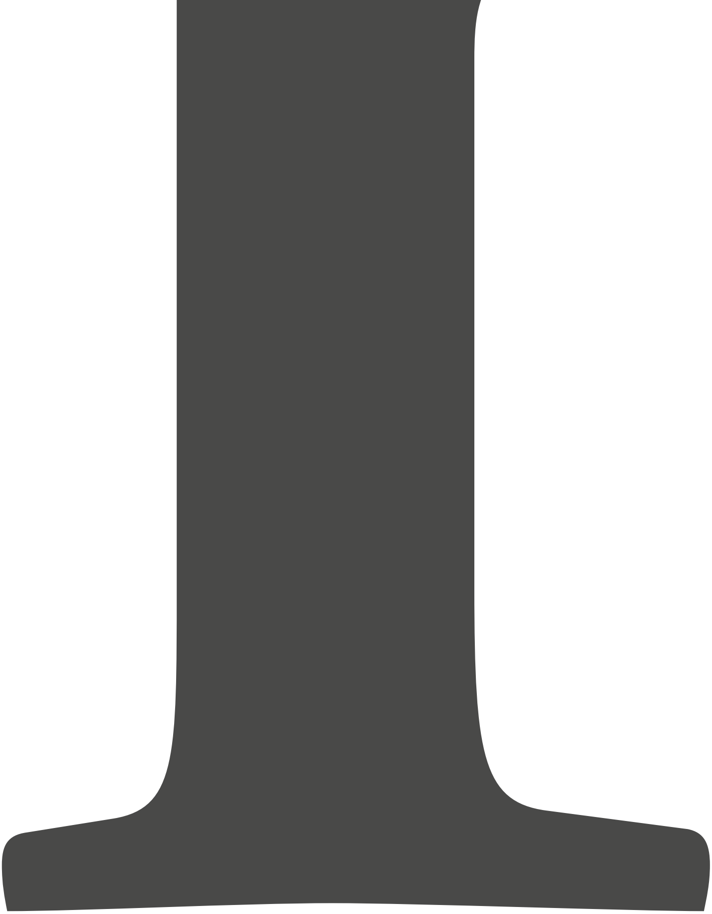


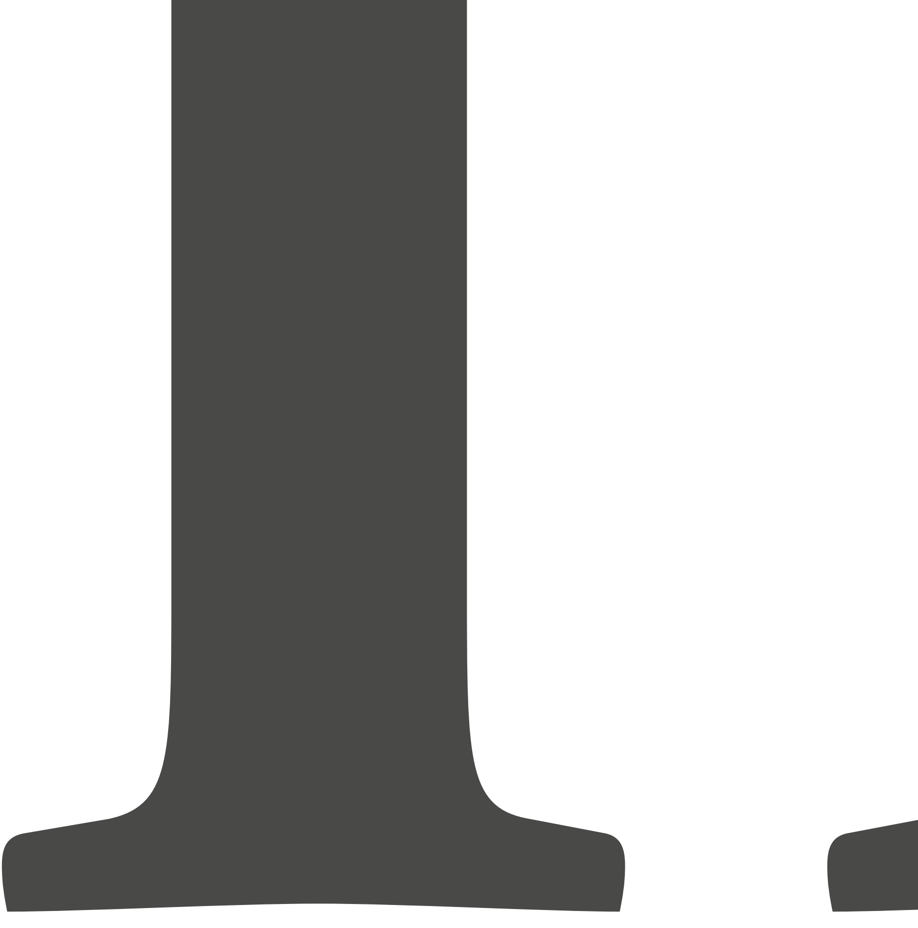




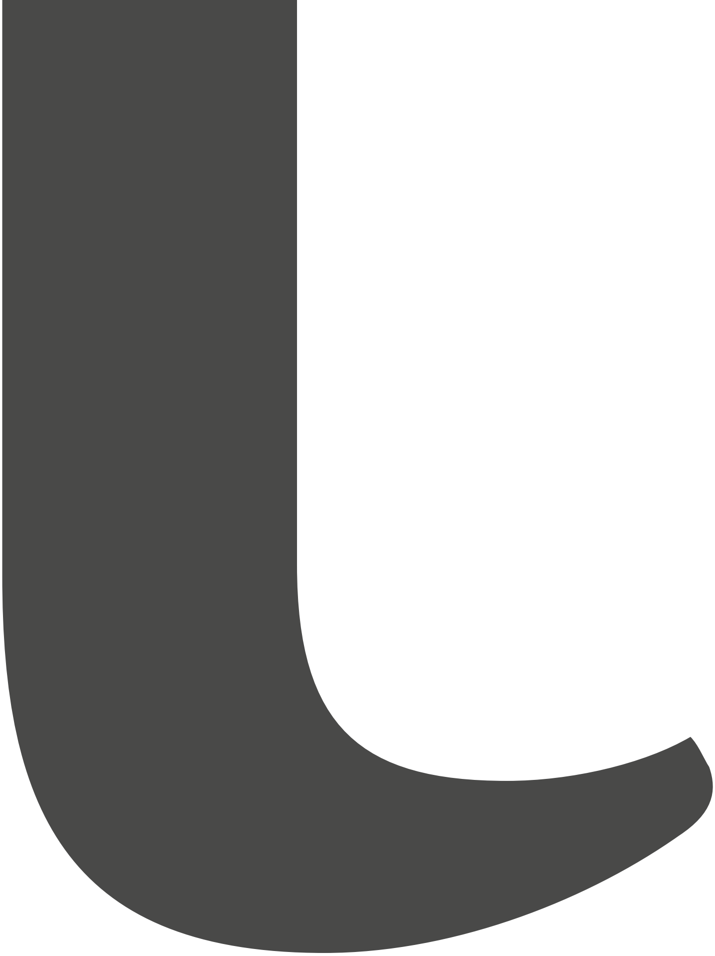
V

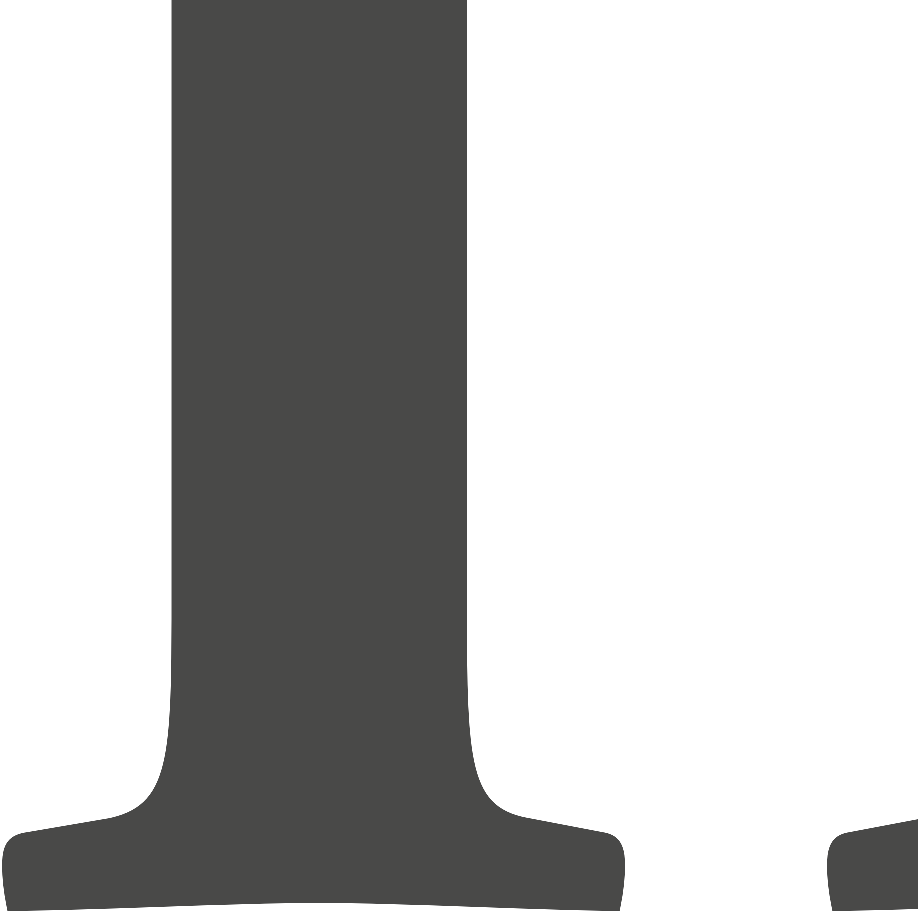


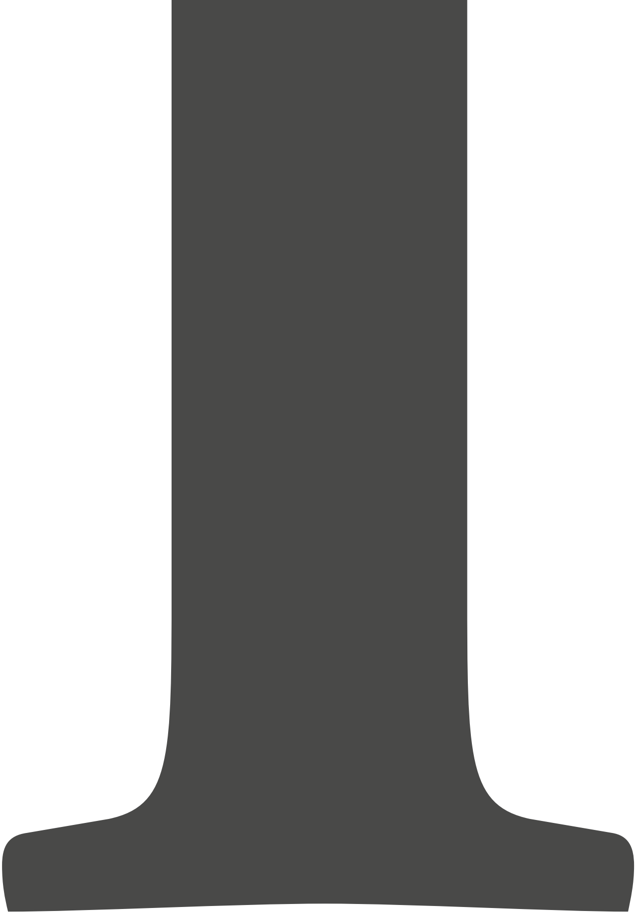


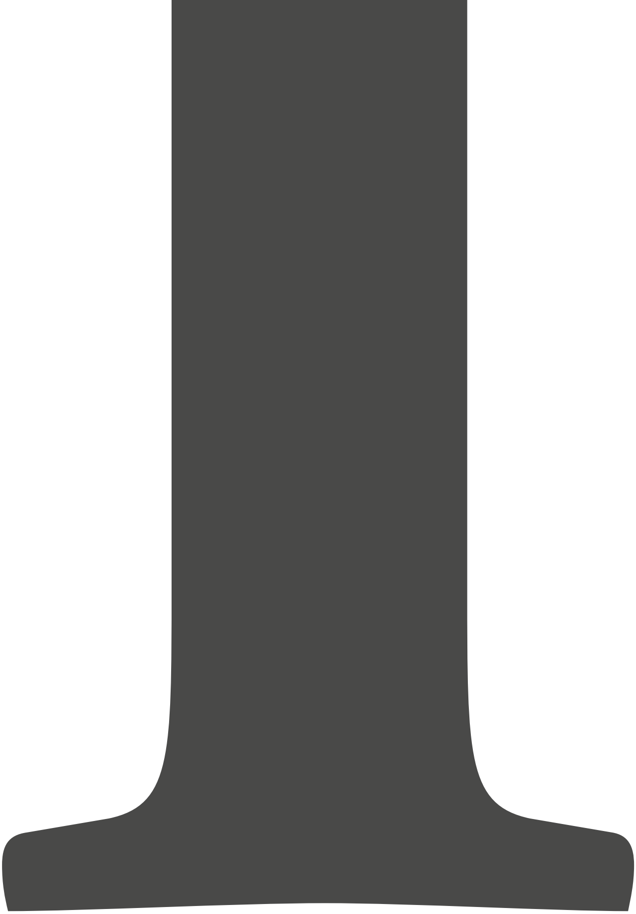


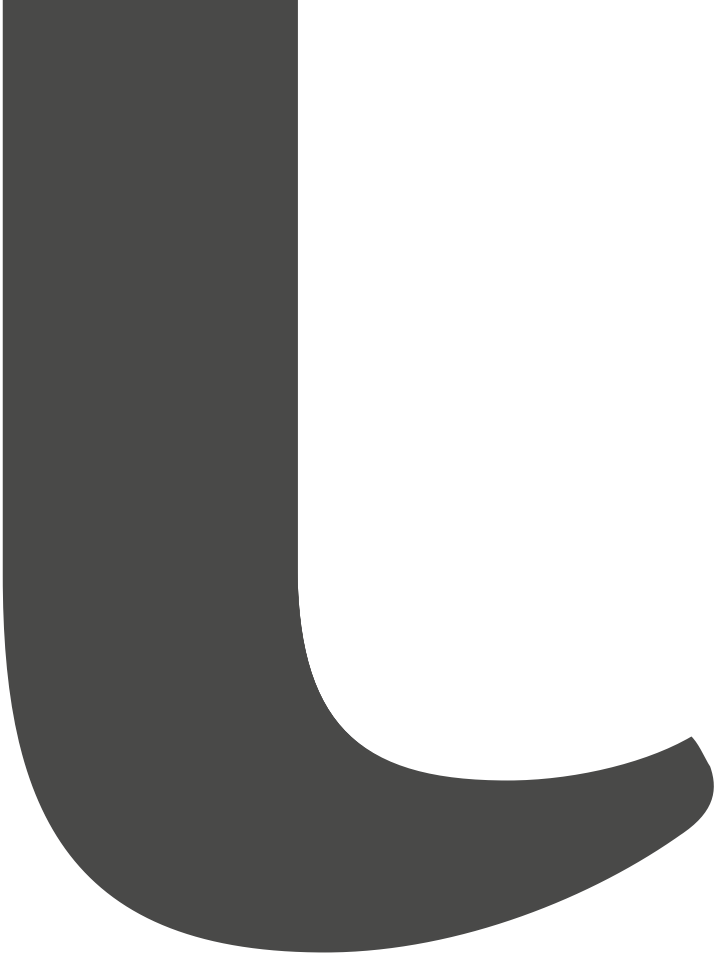
J



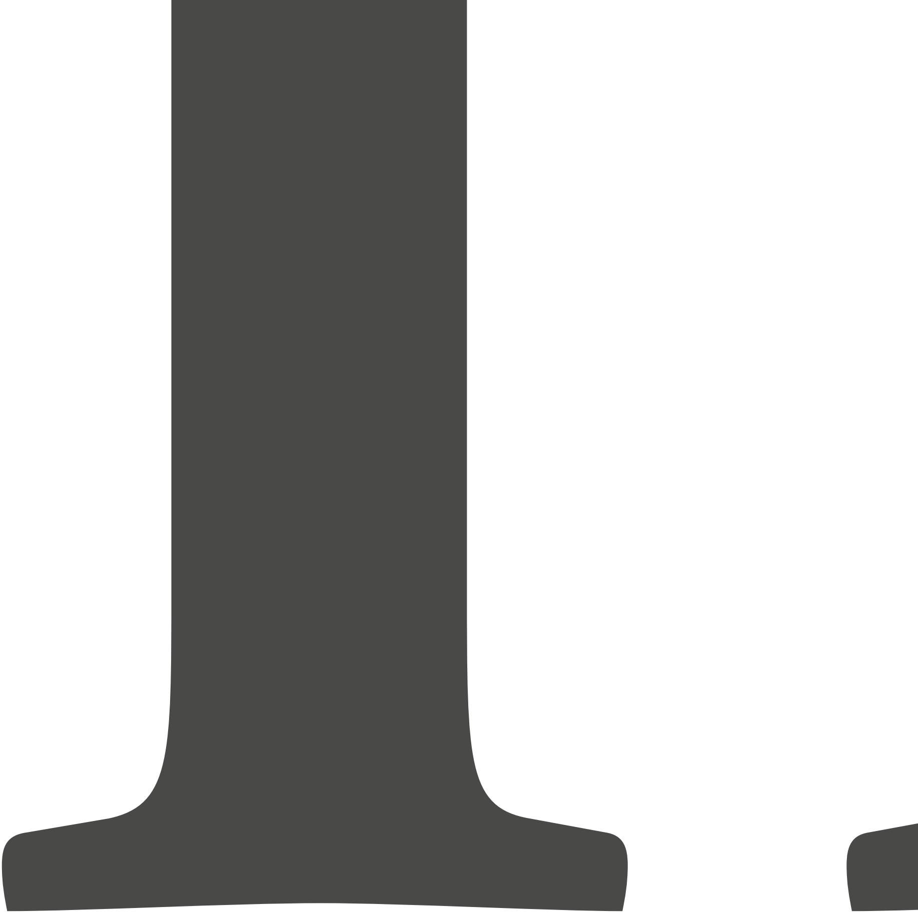


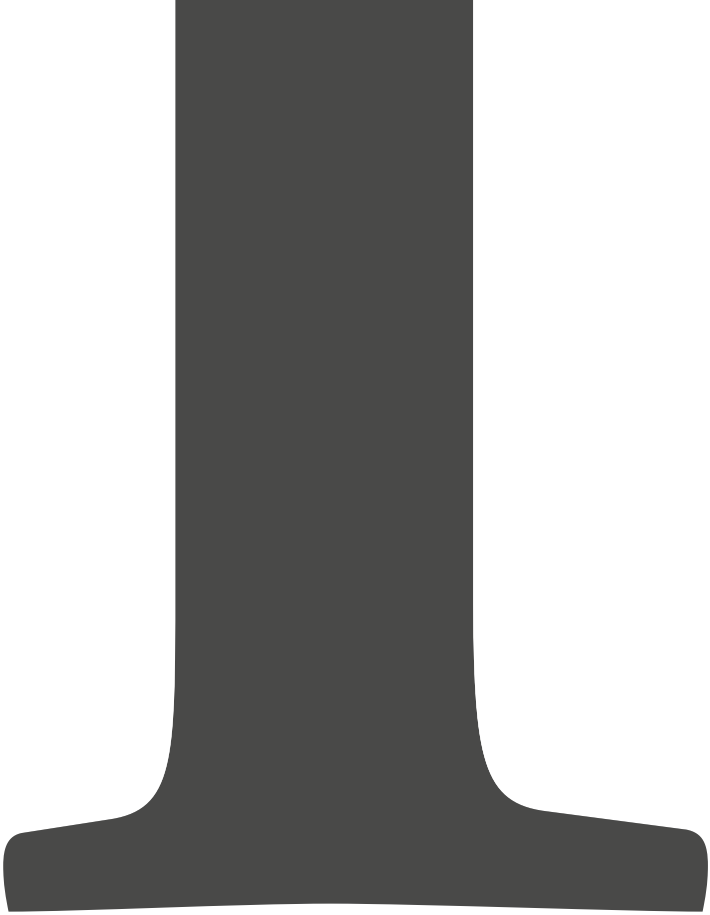


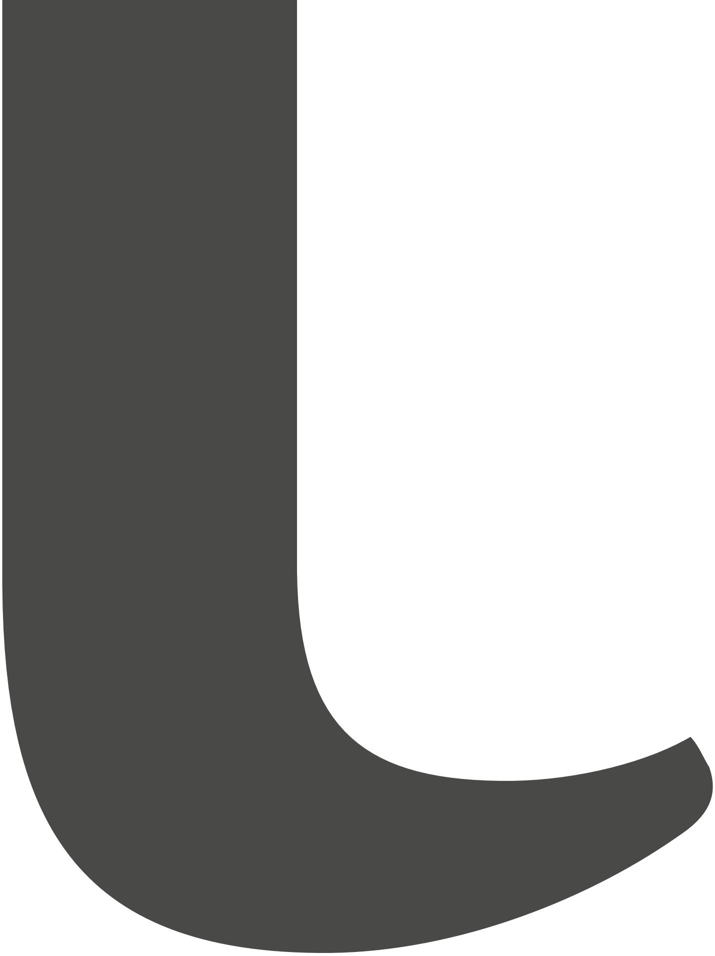


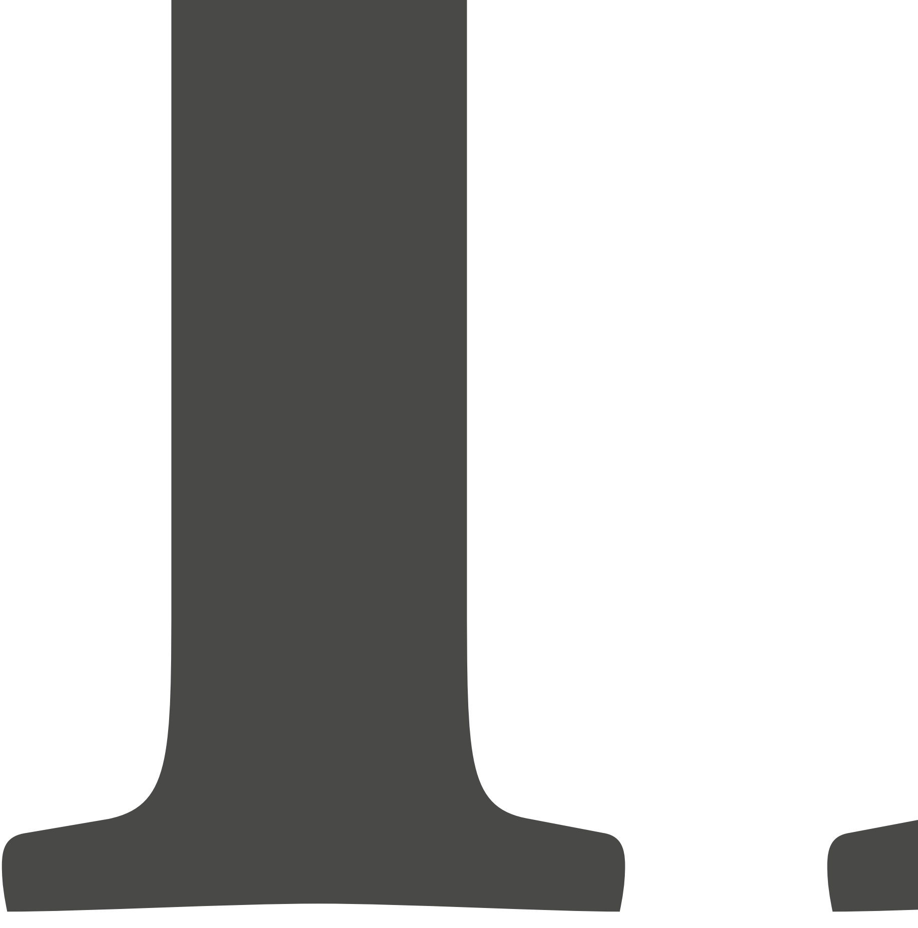


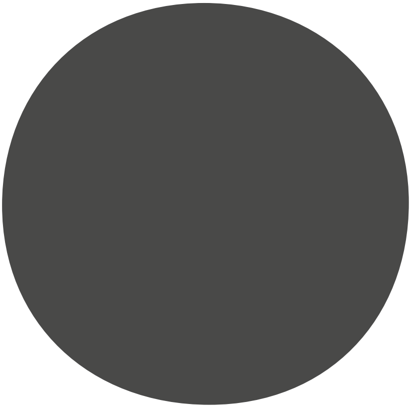
I



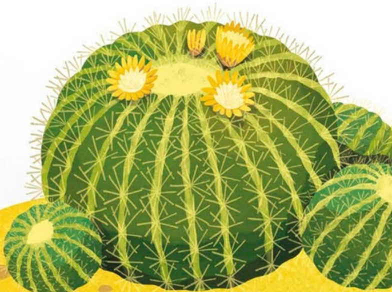








Barrel cactus



Golden barrel cactus

(Echinocactus grusonii)

The golden barrel cactus is an endangered species that lives on a few rocky hillsides in Mexico.

A

[redacted]

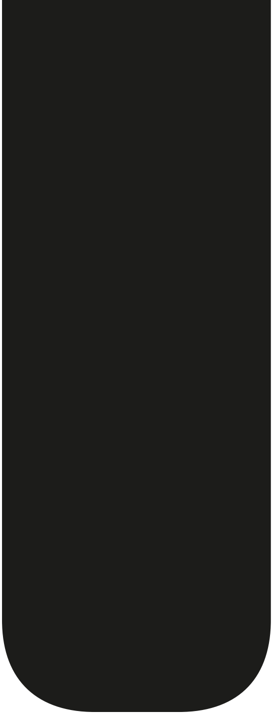
U

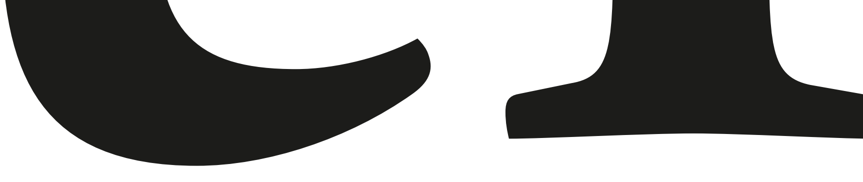
([illegible]

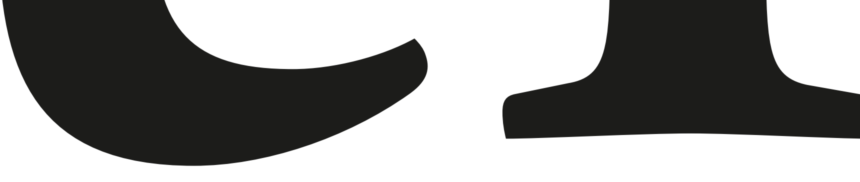
T

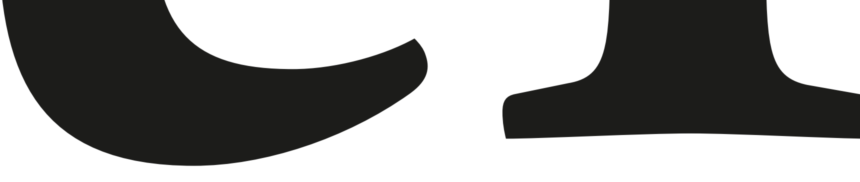
e

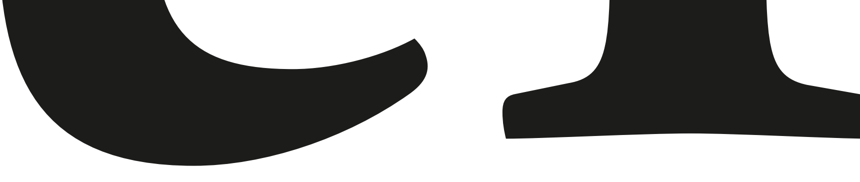
a











T

h

a

li

Plant defenses

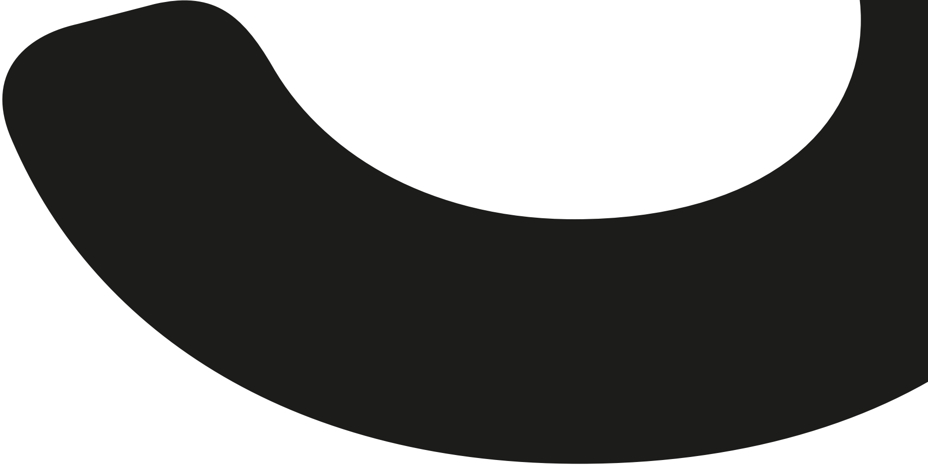
P

p

W

C

g



T

st

h

t

lo

T

S

tr

p

th

T

W

W

is

d

M

t

C

T

b

T

a

in

th

fr

Physical or chemical

Physical defenses, such as thorns and prickles, make pl
painful to touch and handle. Chemical defenses, inclu
poison, make them taste nasty or cause illness. Some p
have both types of protection.

L

[redacted]

T

W

st

fu

fr

p

l

tr

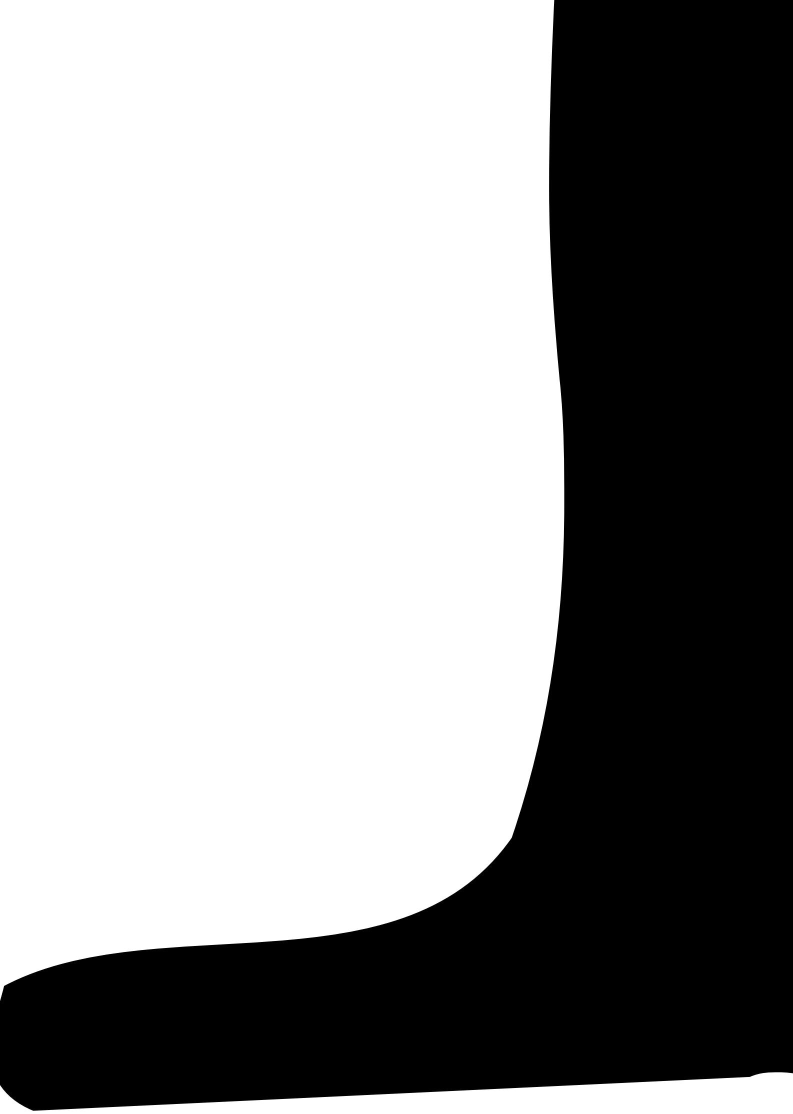
b

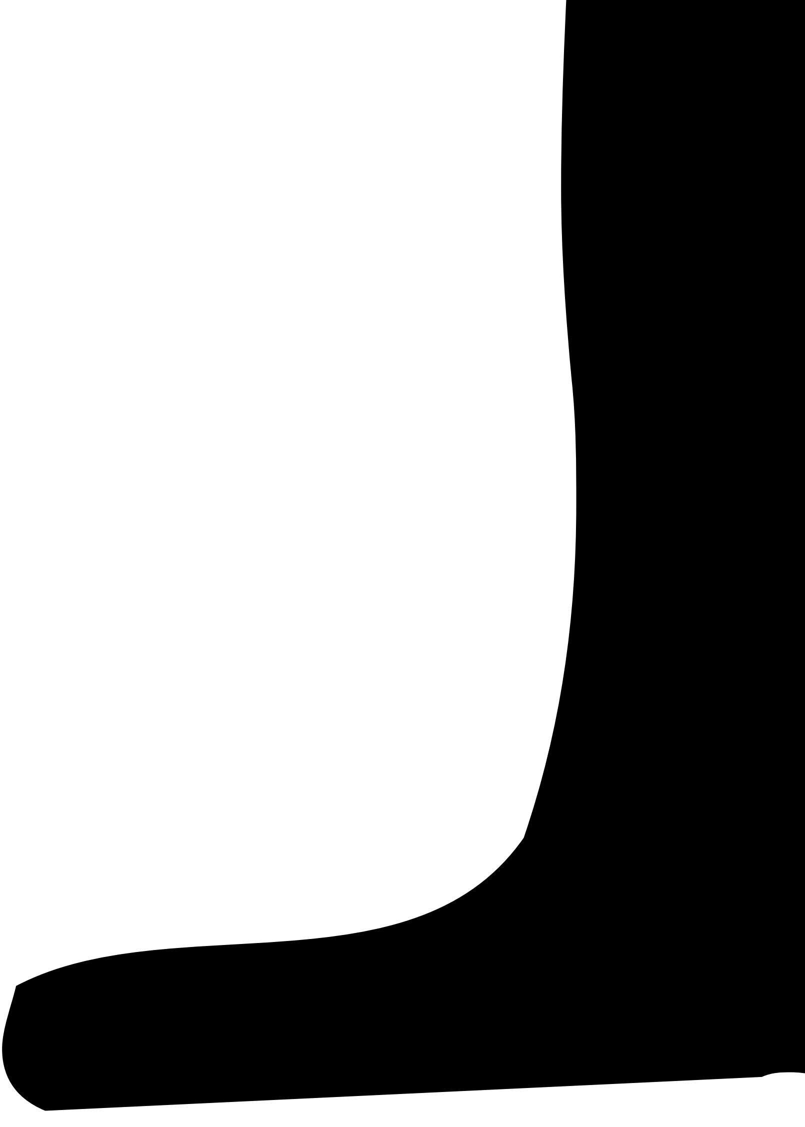
C

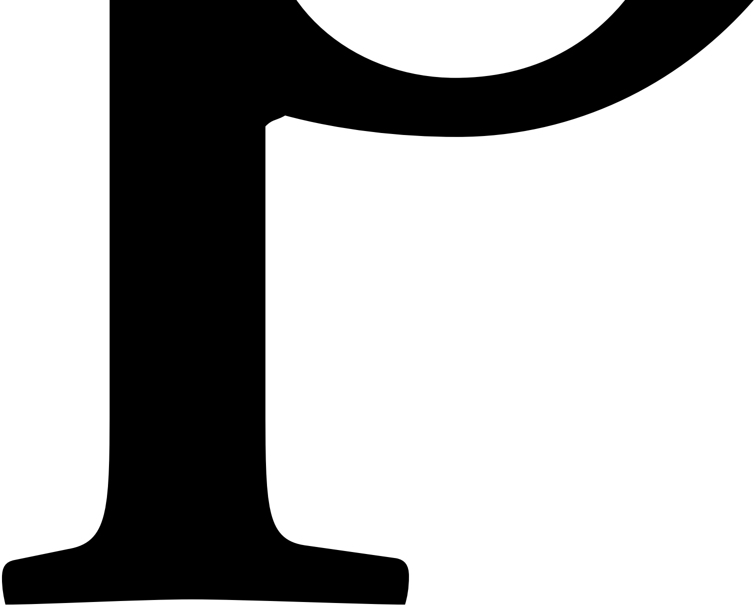
p

th

S







p

In

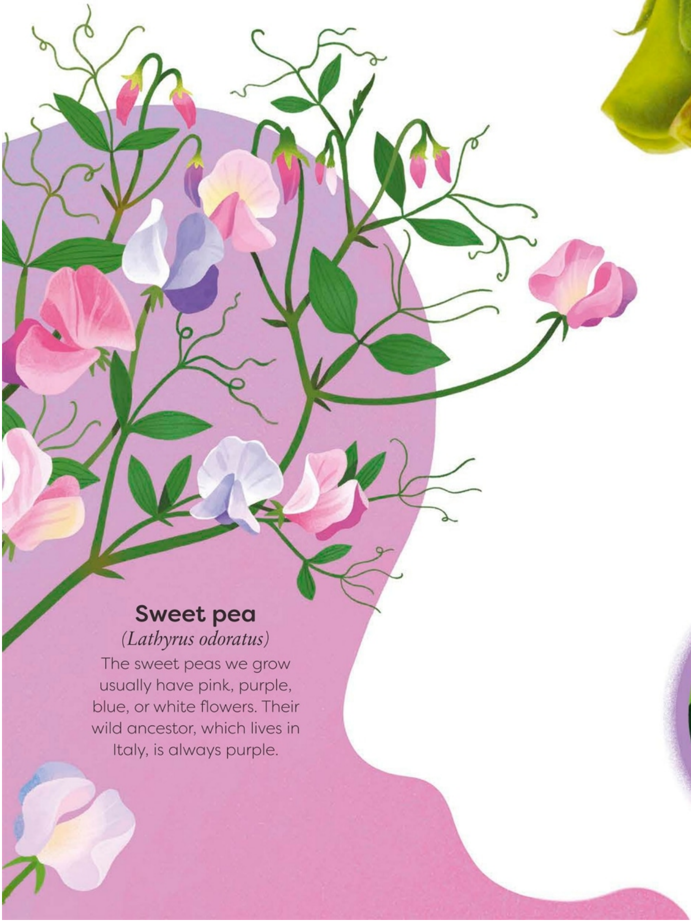
re

Si

T

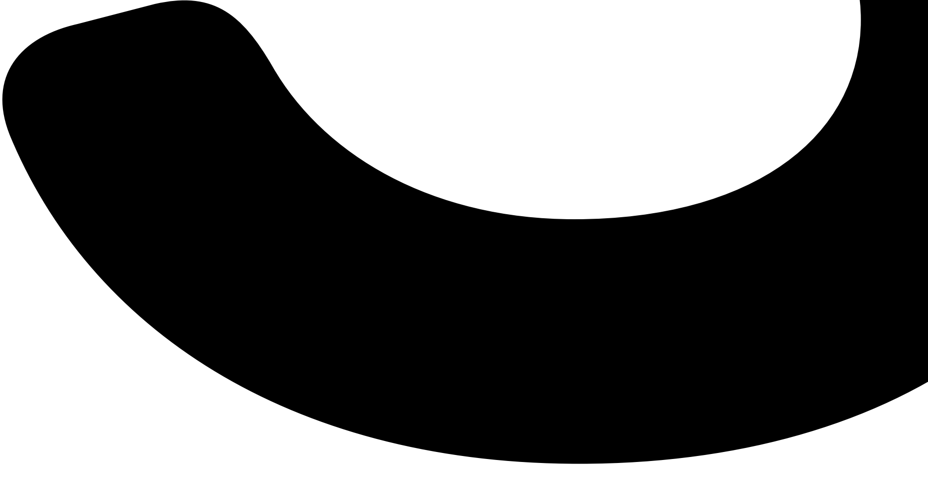
a

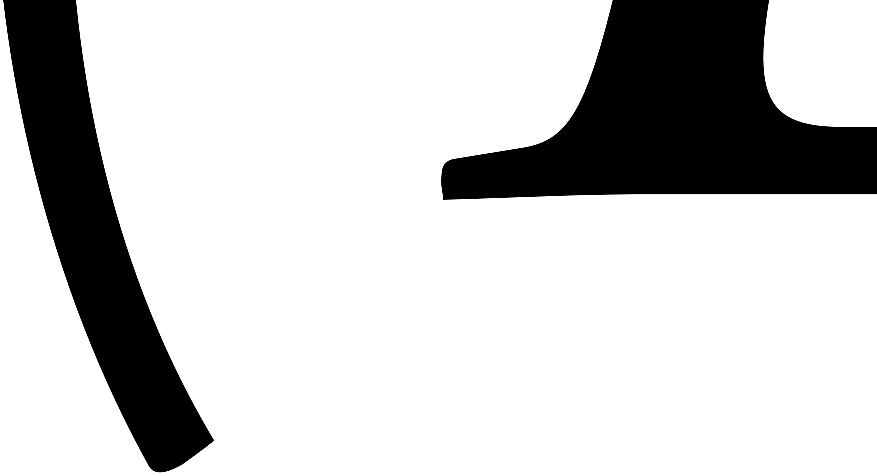
sh



Sweet pea
(Lathyrus odoratus)
The sweet peas we grow usually have pink, purple, blue, or white flowers. Their wild ancestor, which lives in Italy, is always purple.

0





T

u

b

w

lt

S

C

th

ri

h

le

Te

th

W

m

T

p

W

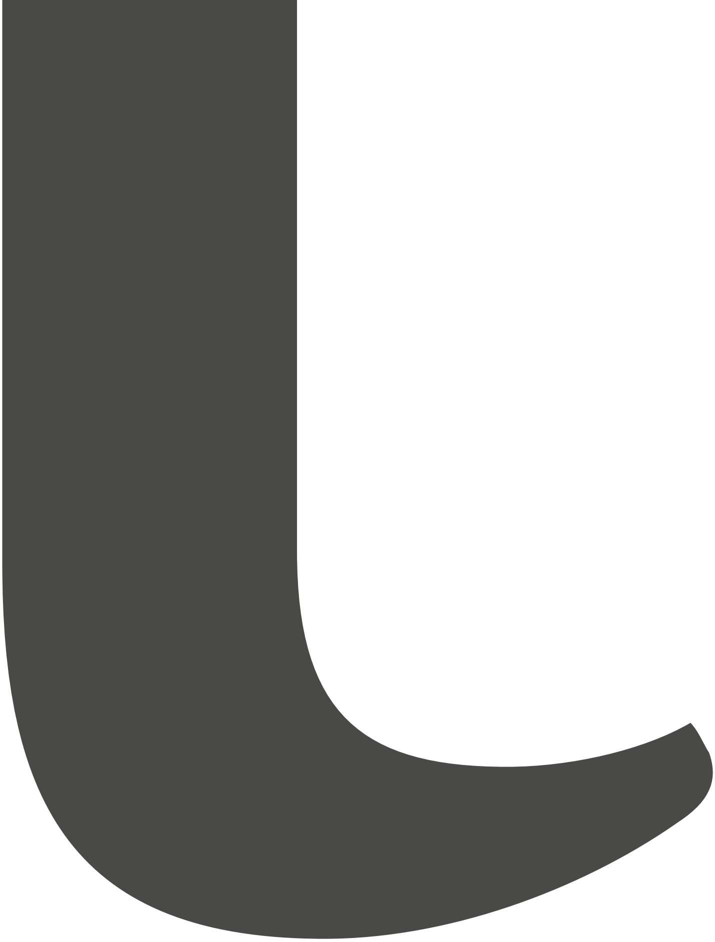
C

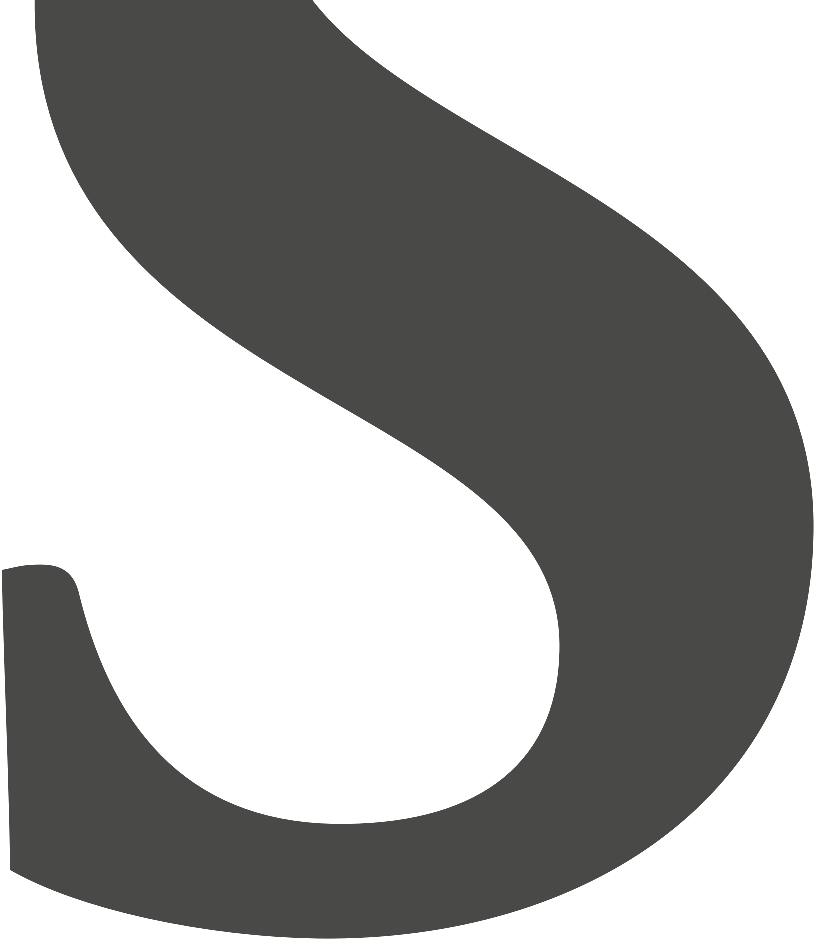
T

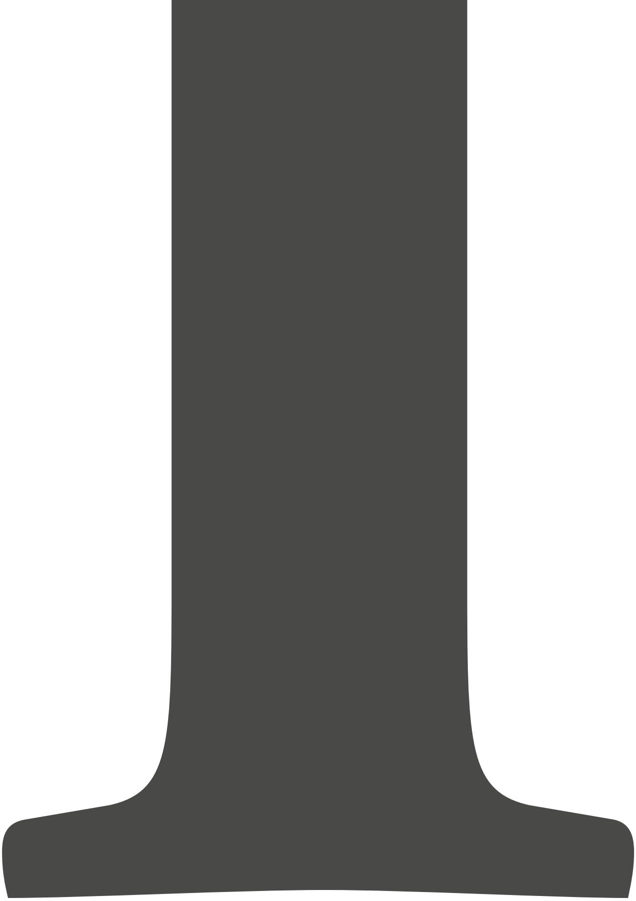
d

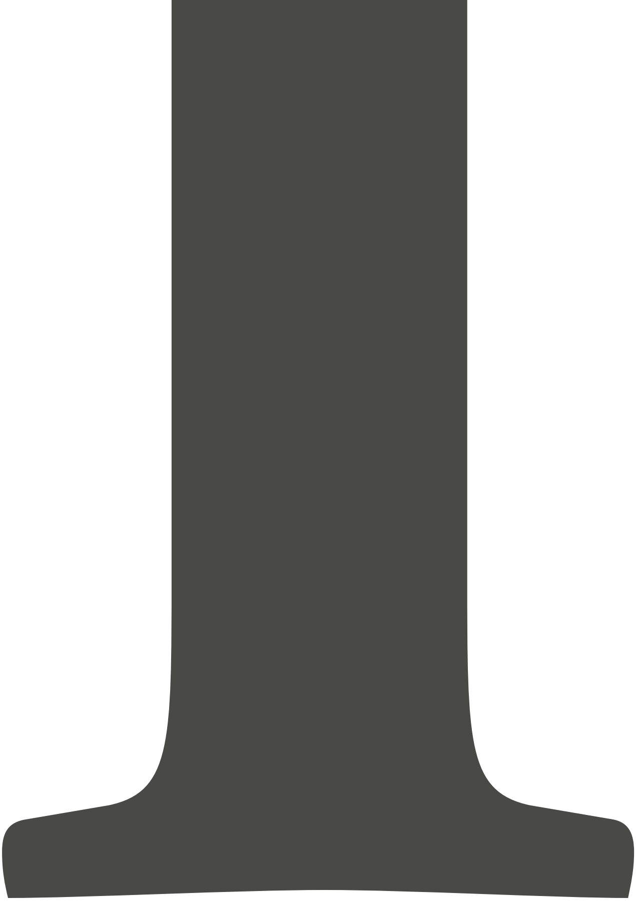
a

V



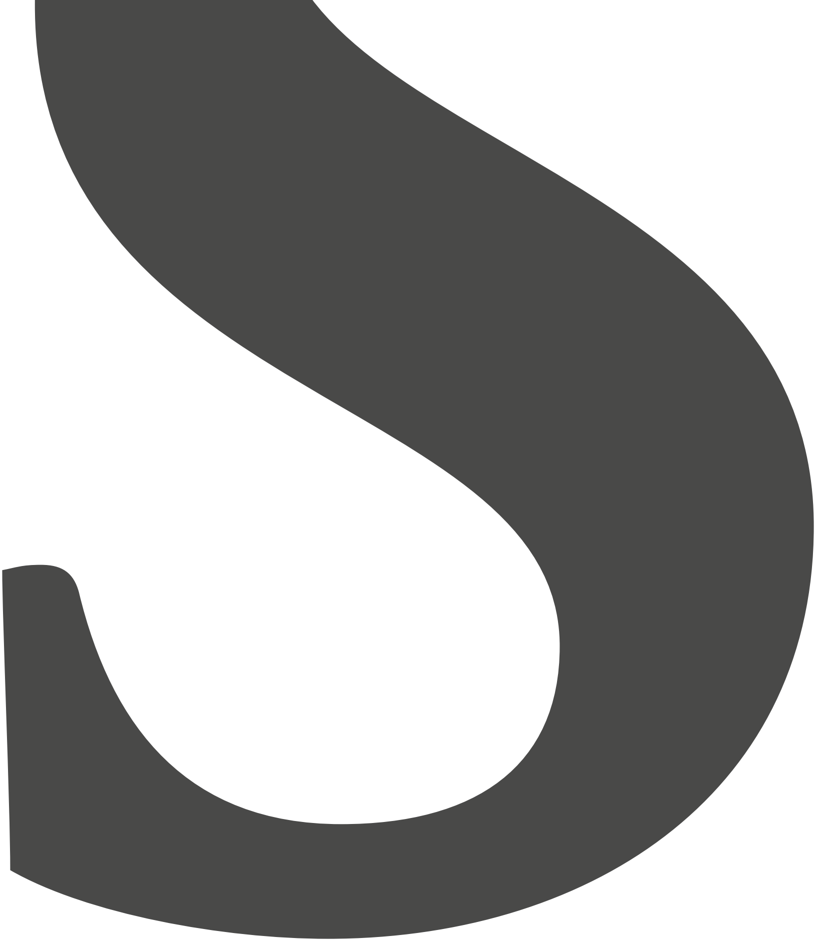


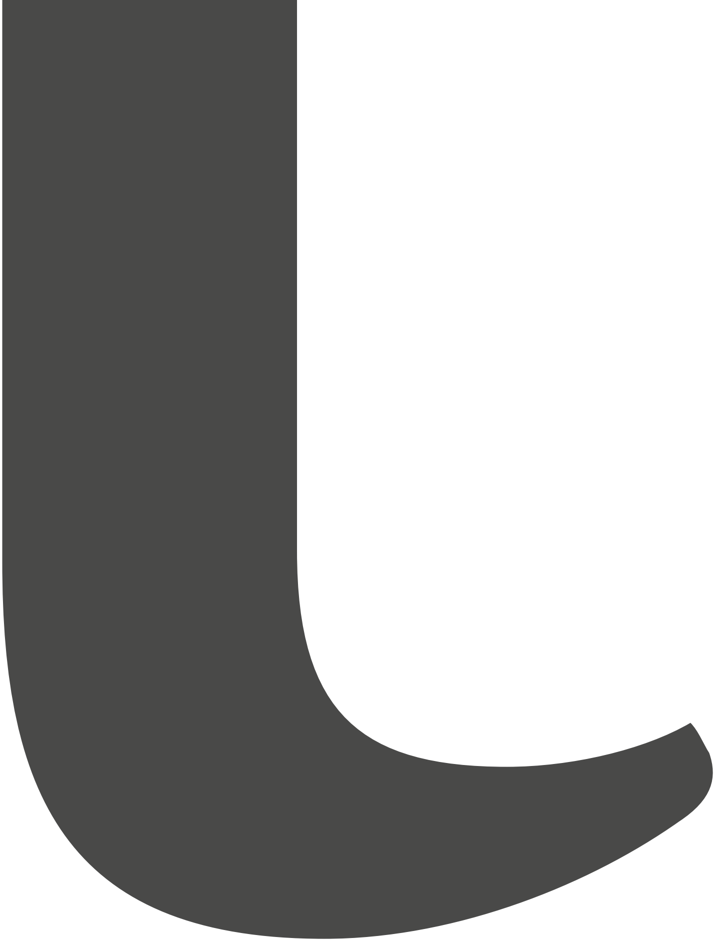


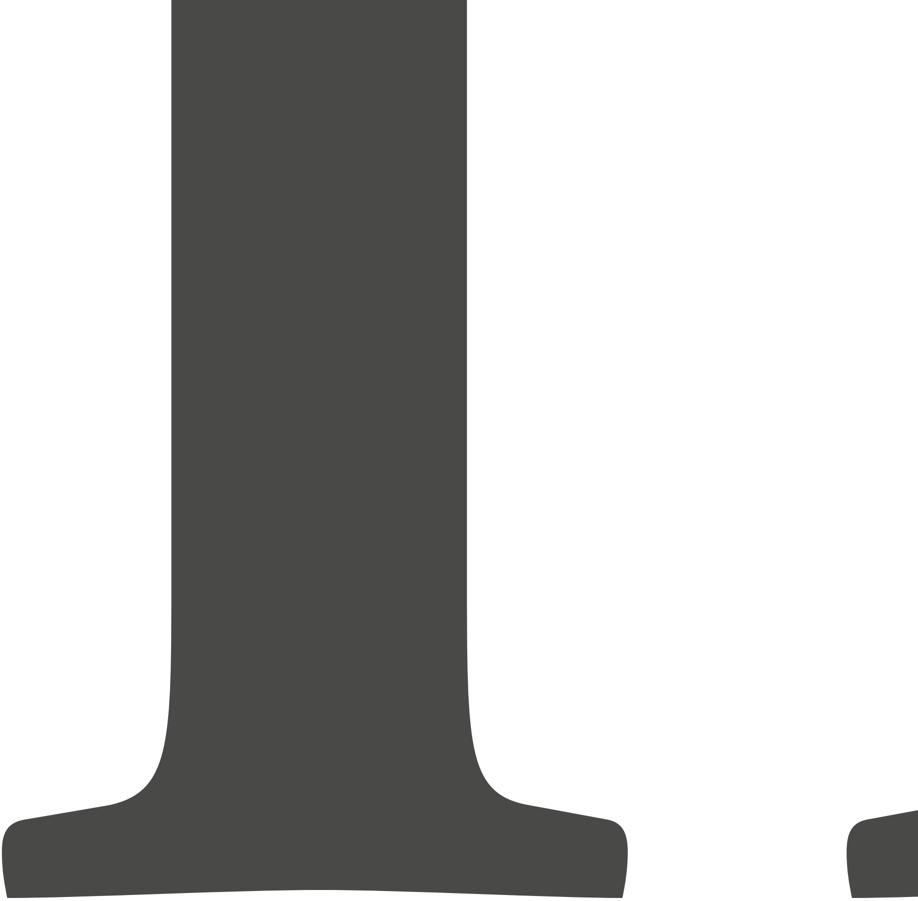


V

J





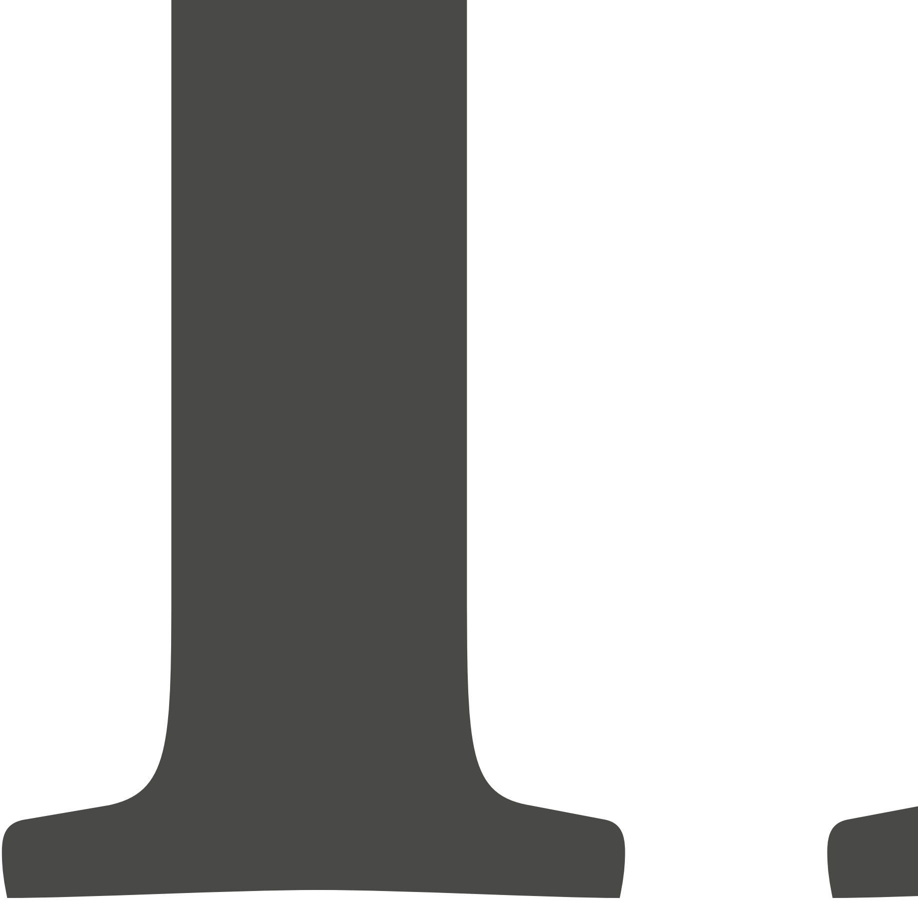


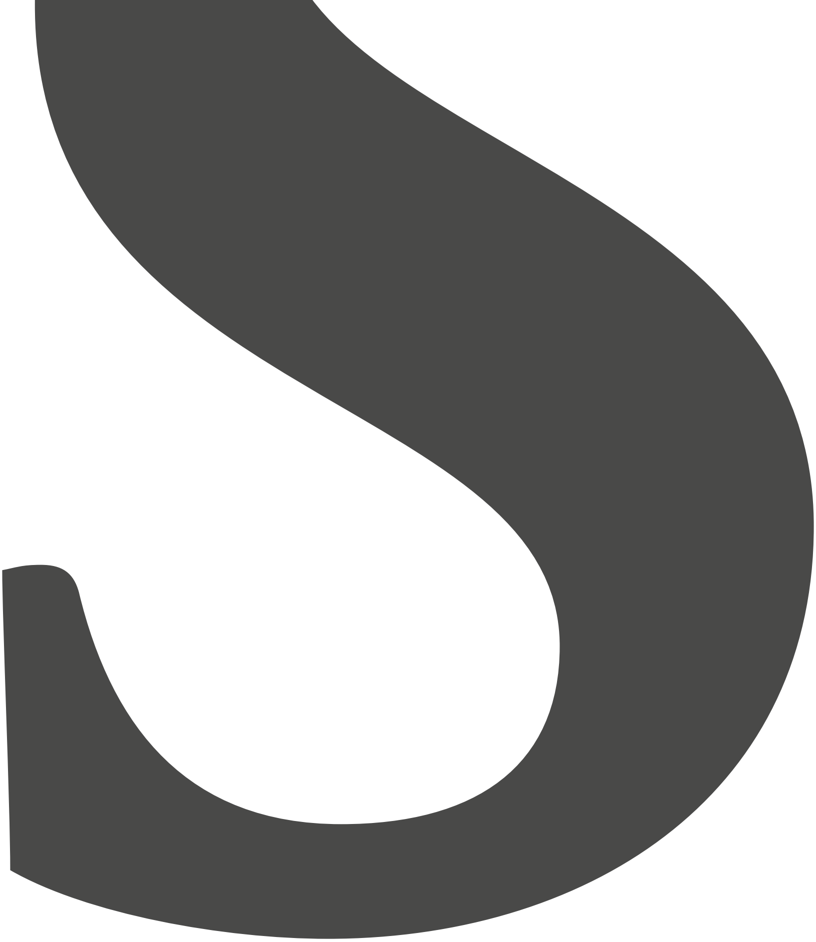
y

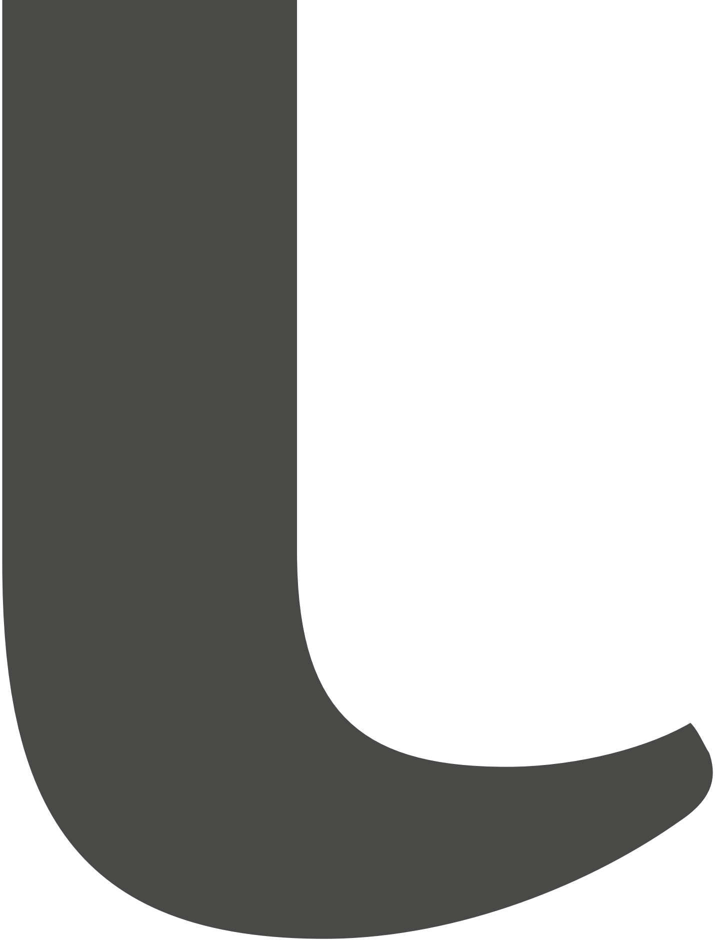
1

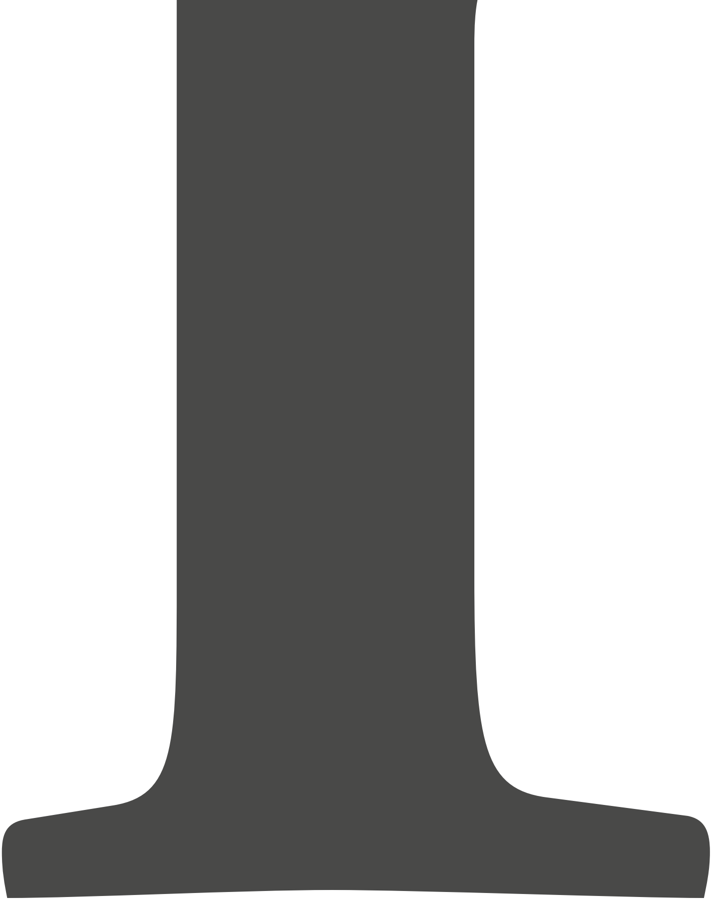
,

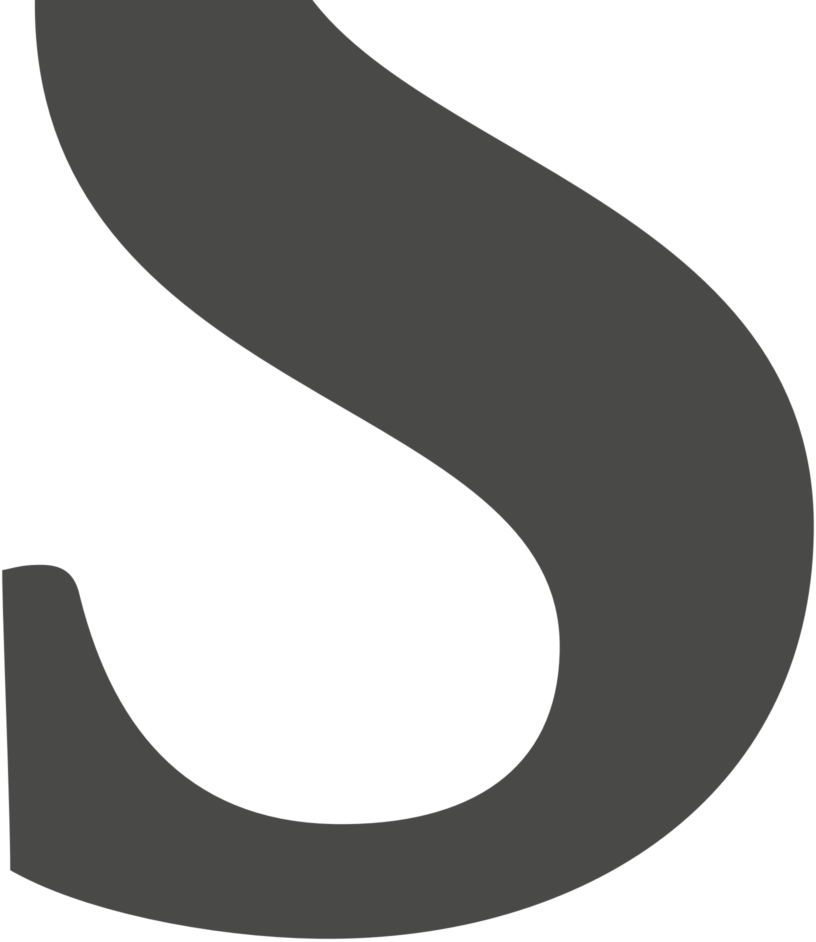
S



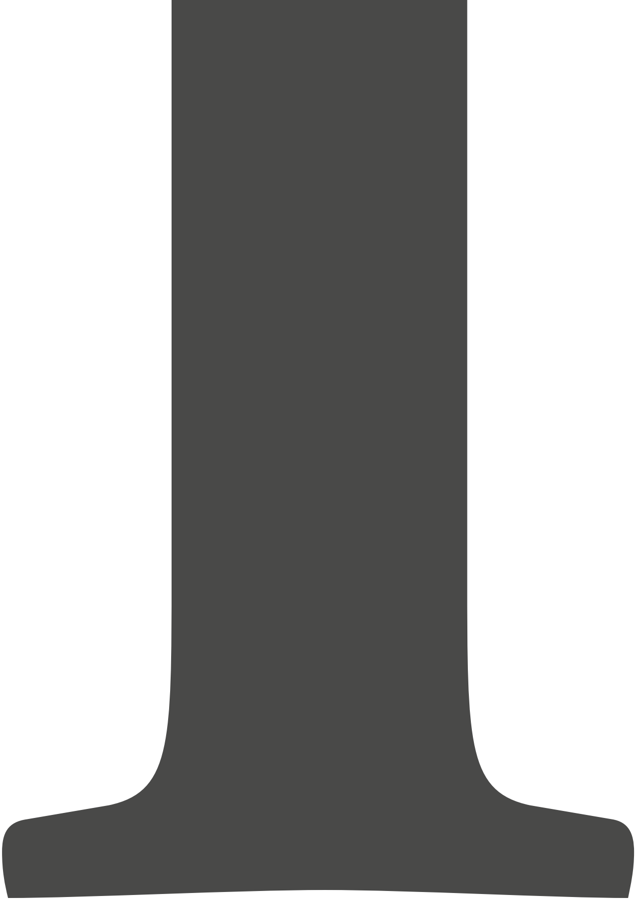


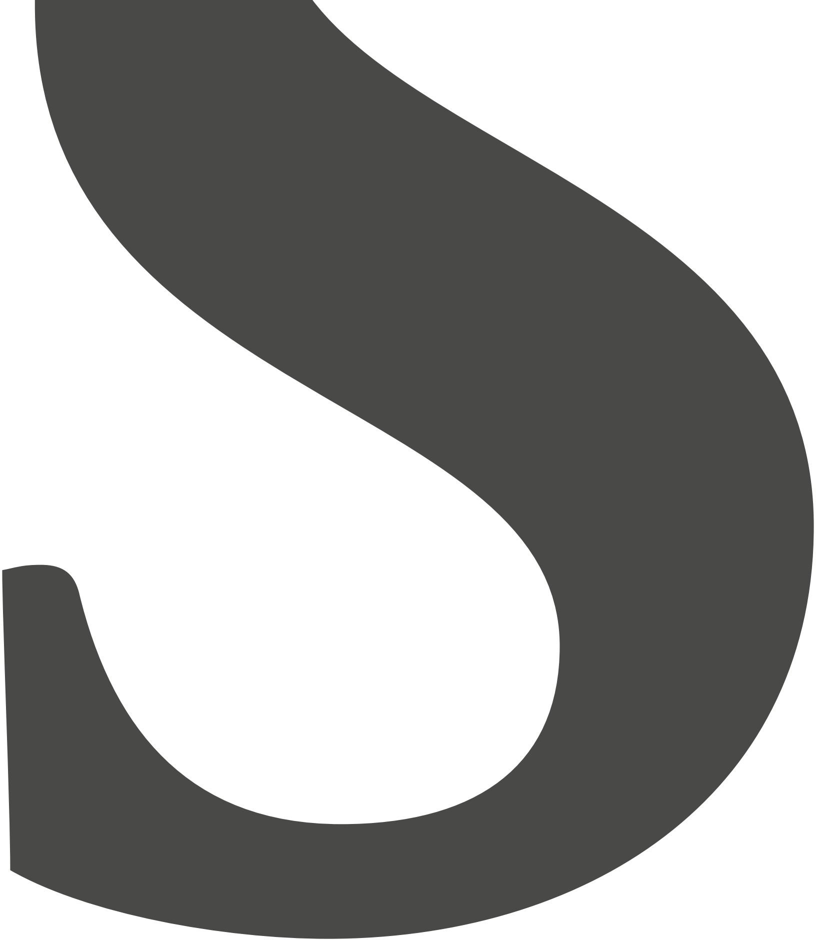




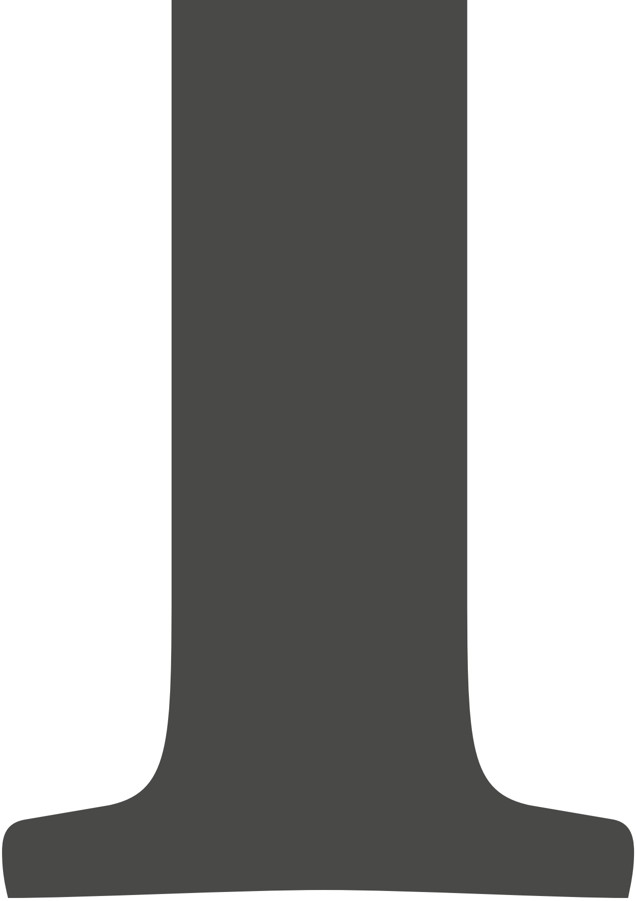


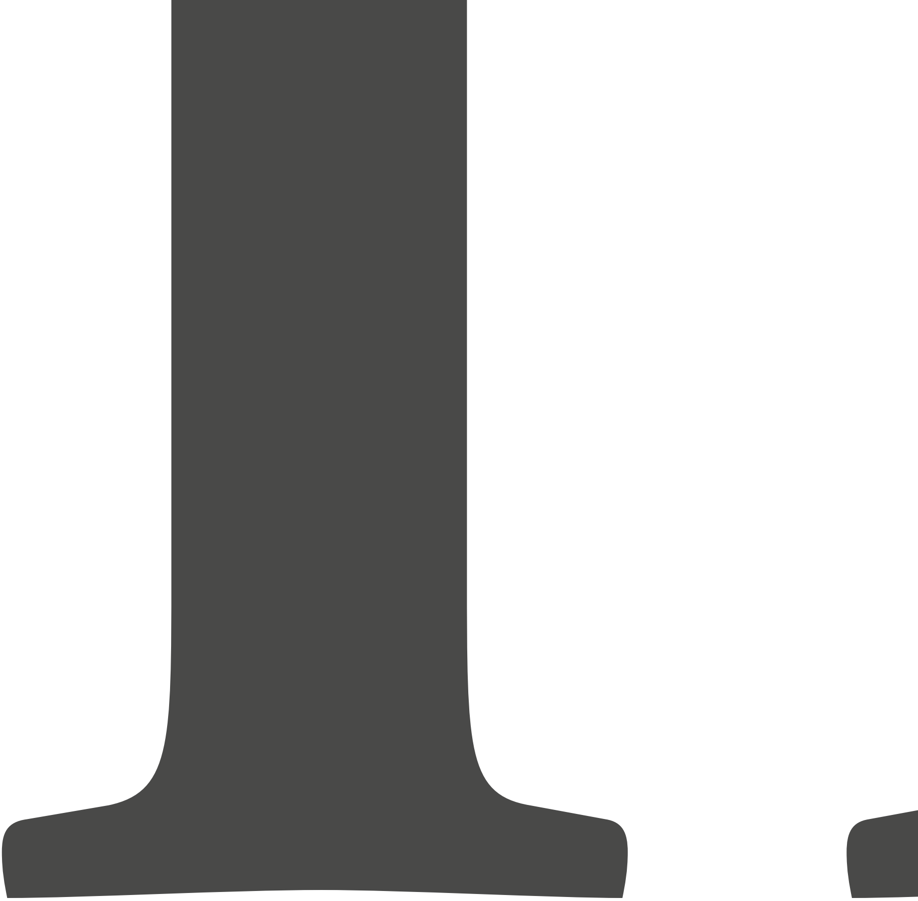
V

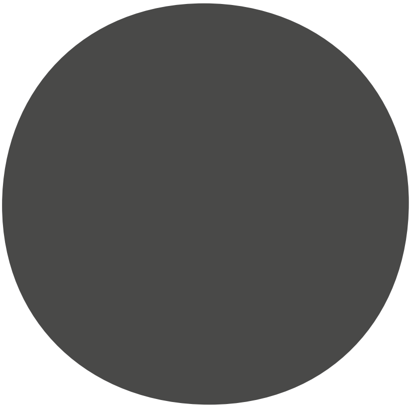




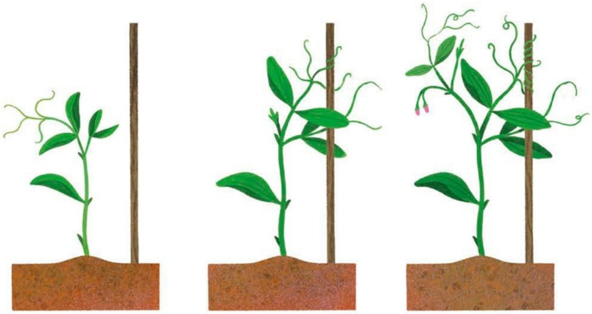
1







Sweet pea

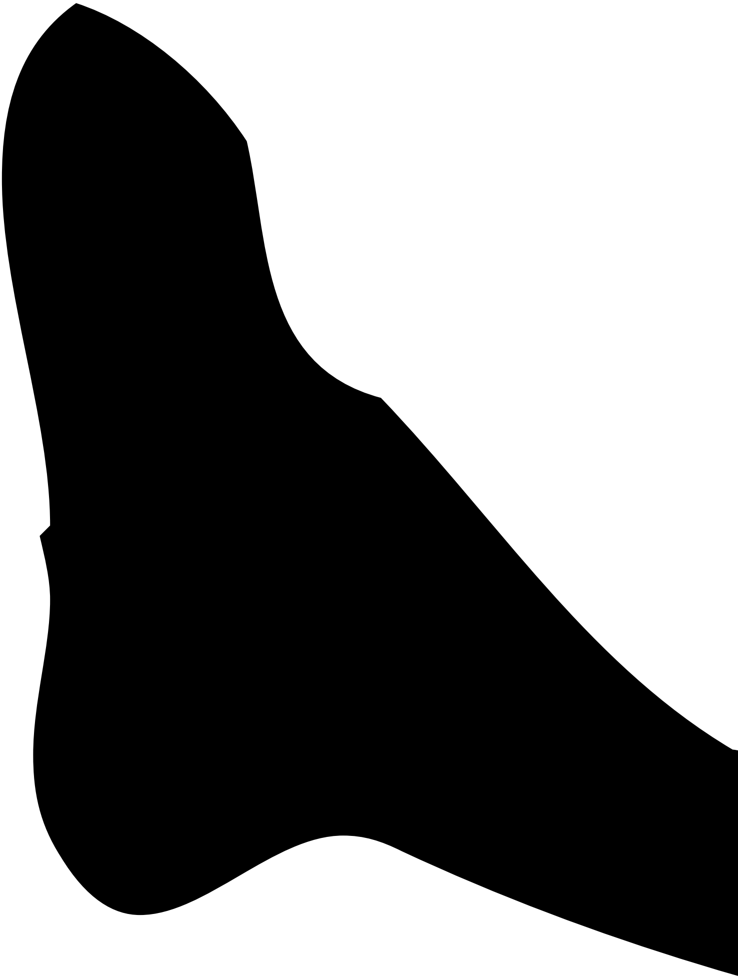


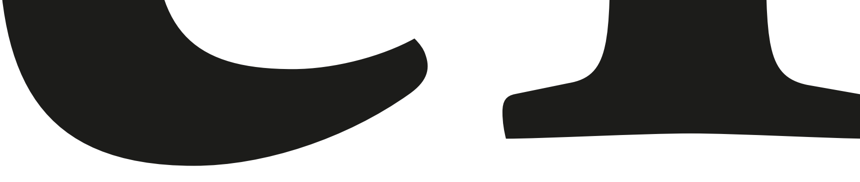
Finding support

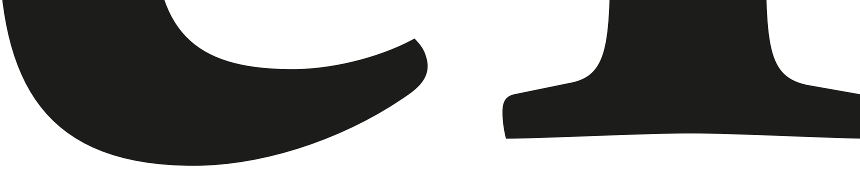
Sweet peas tendrils exten
from the plant. They slowl
circles as they grow, like so
swinging a rope around th
When they touch an objec
twist around it. In gardens
provide supports for the p

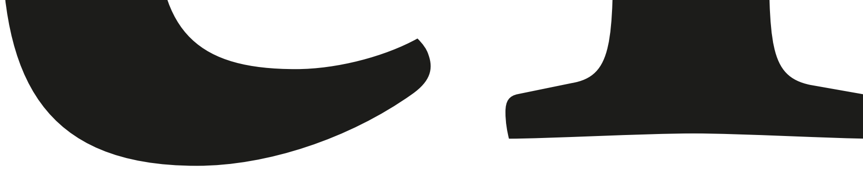
"

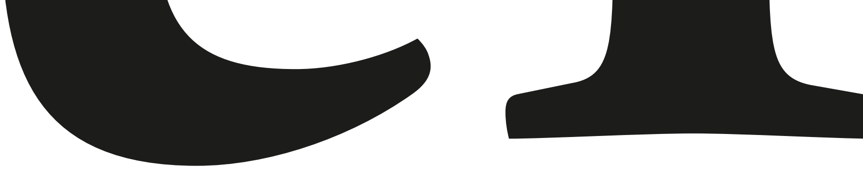
[redacted]











S

fr

Ci

S

W

t

p

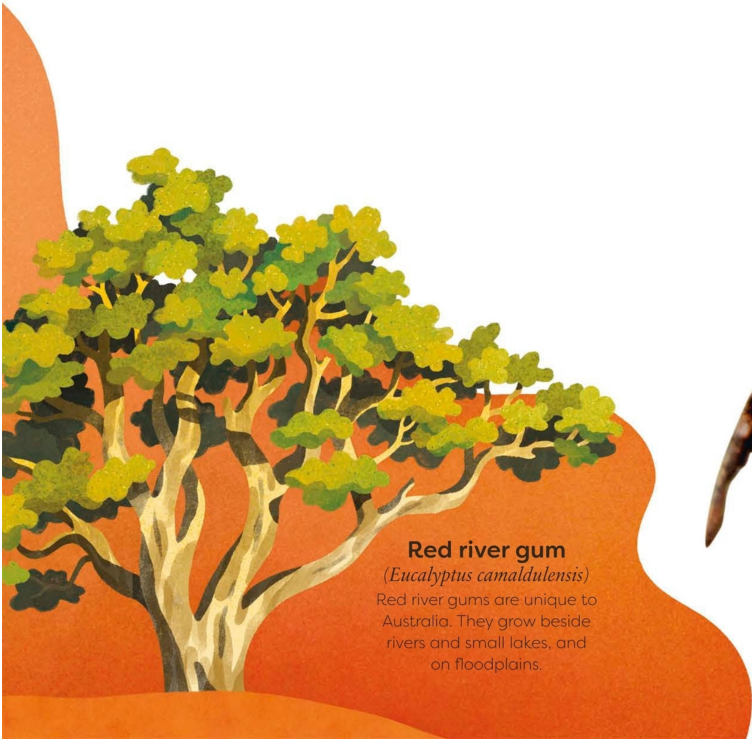
T

a

T

m

Red river gum



Red river gum
(Eucalyptus camaldulensis)
Red river gums are unique to Australia. They grow beside rivers and small lakes, and on floodplains.

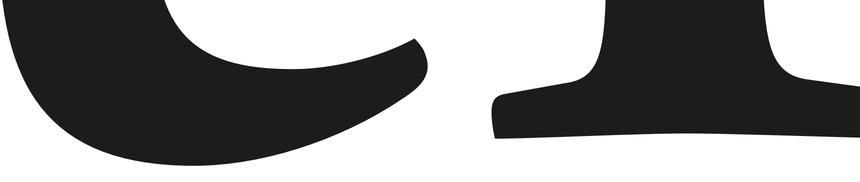
(

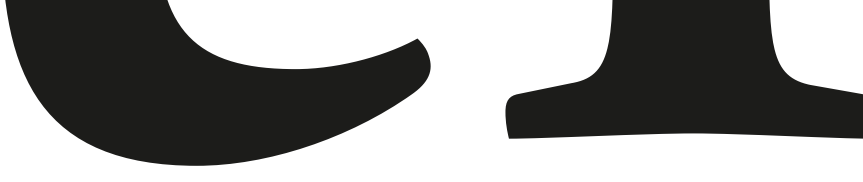
R

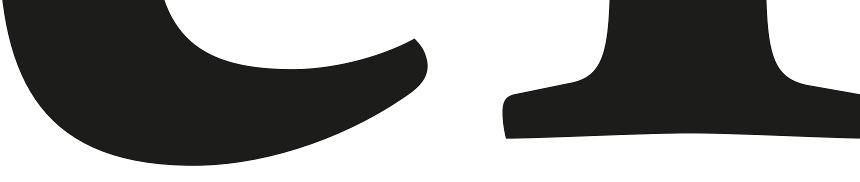
A

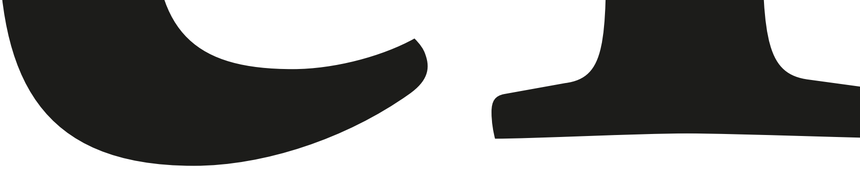
ri

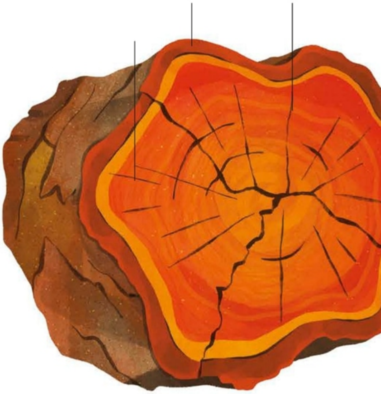
o











Red wood

At the center of every tree trunk is the heartwood, which in red river gums is blood-red. Trees usually add a new ring of heartwood each year, so by counting the rings you can tell how old the tree is

[redacted]

V

G

U

IV

A

h

b

O

th

u

p

a

g

d

H

B

R

B

cr

si

g

T

of

T

tr

th

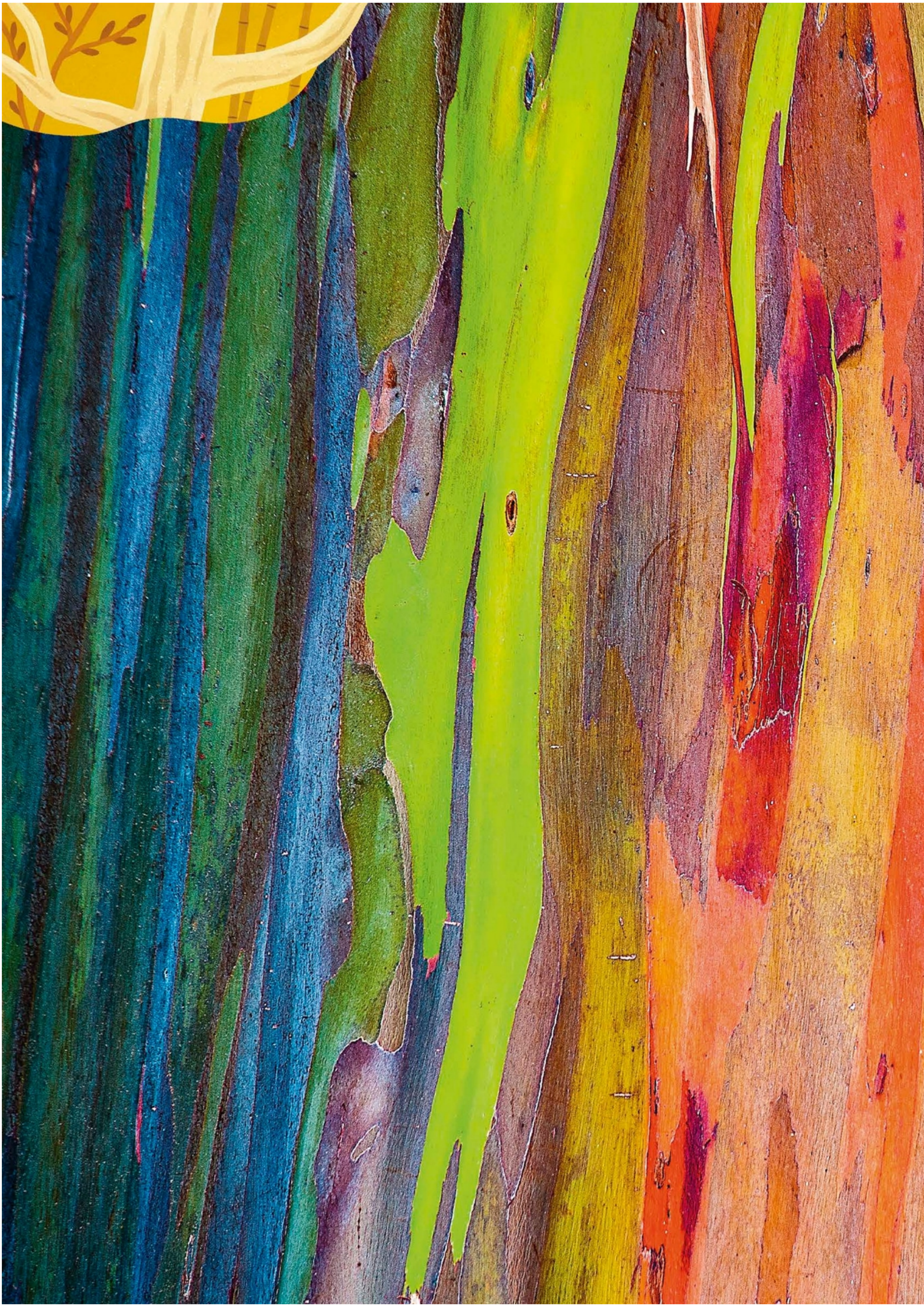
H

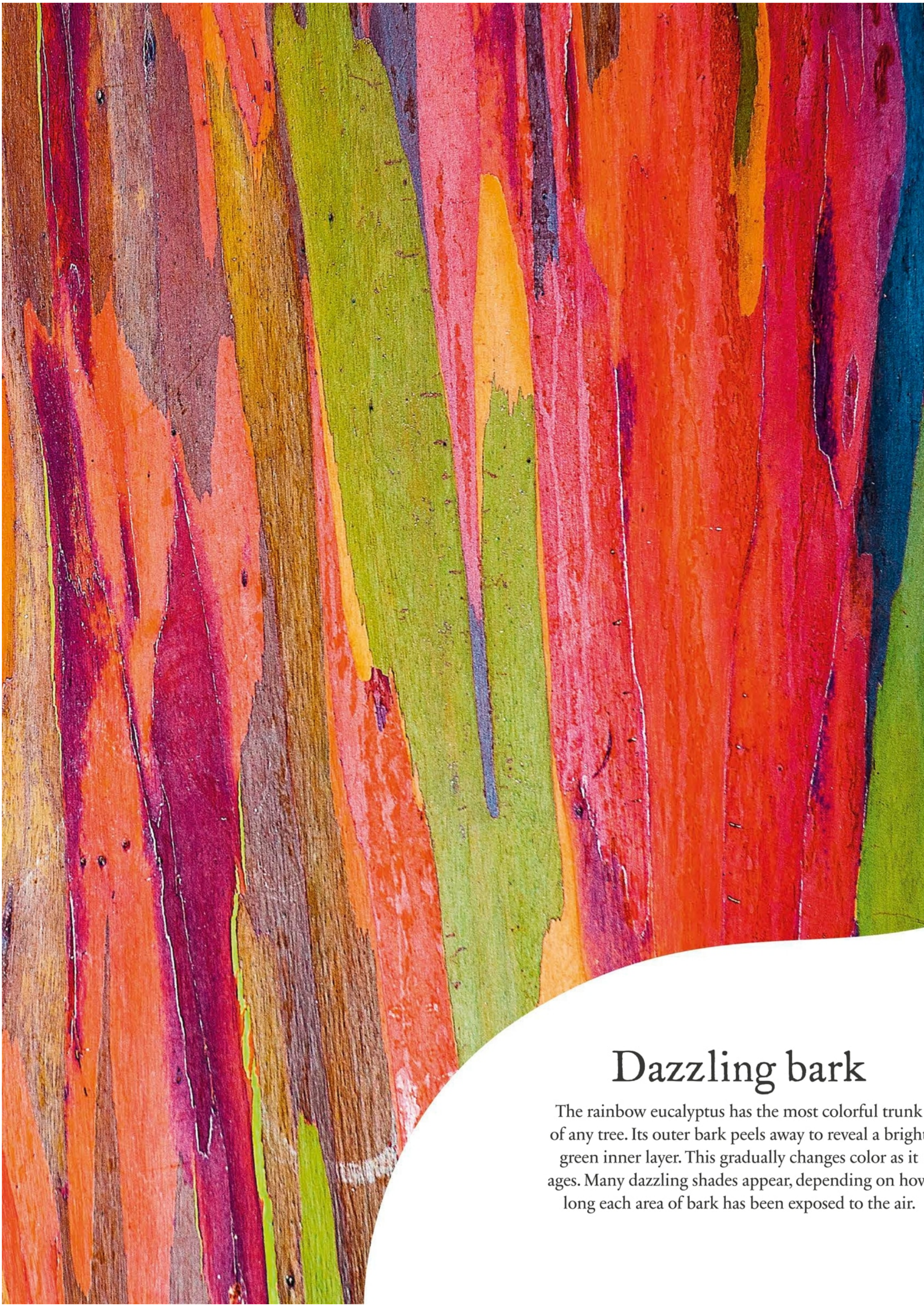
tr

a

p

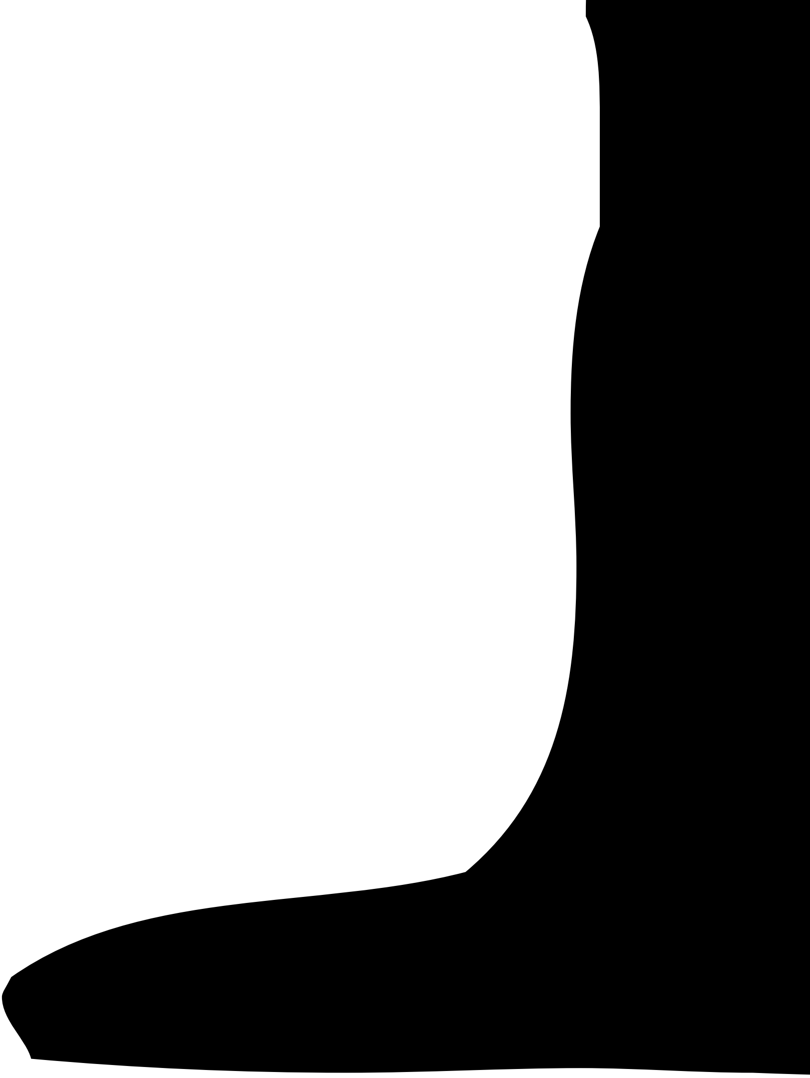
sr

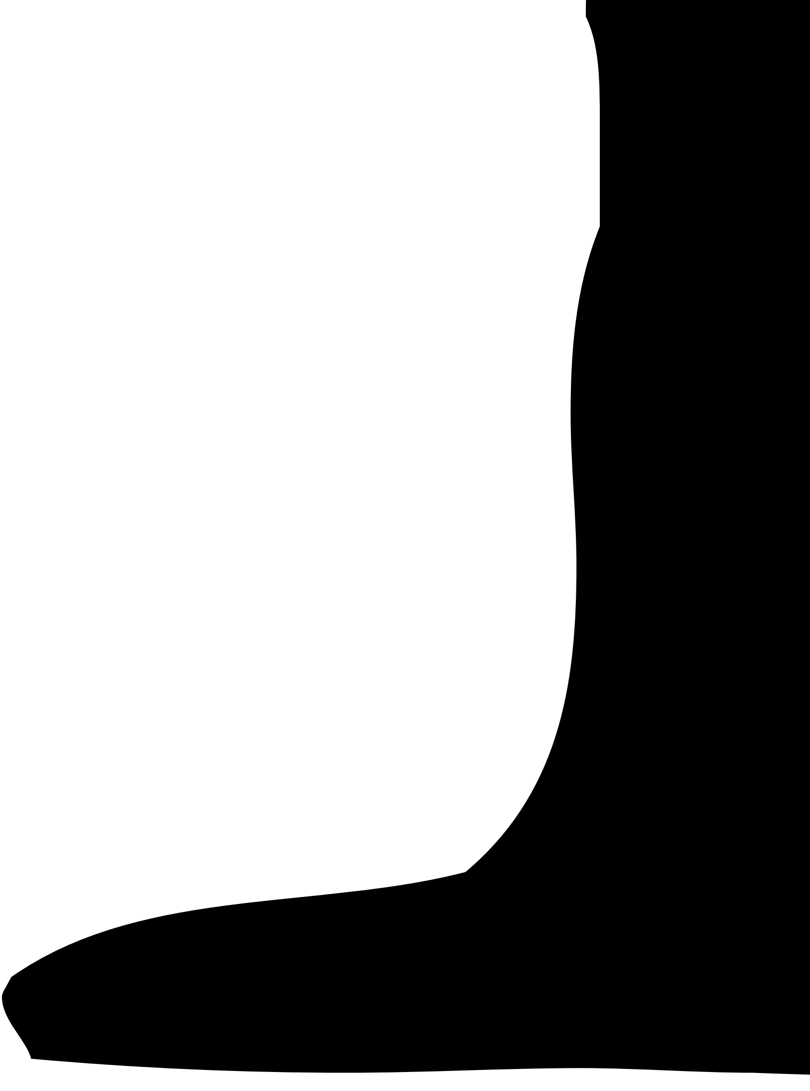




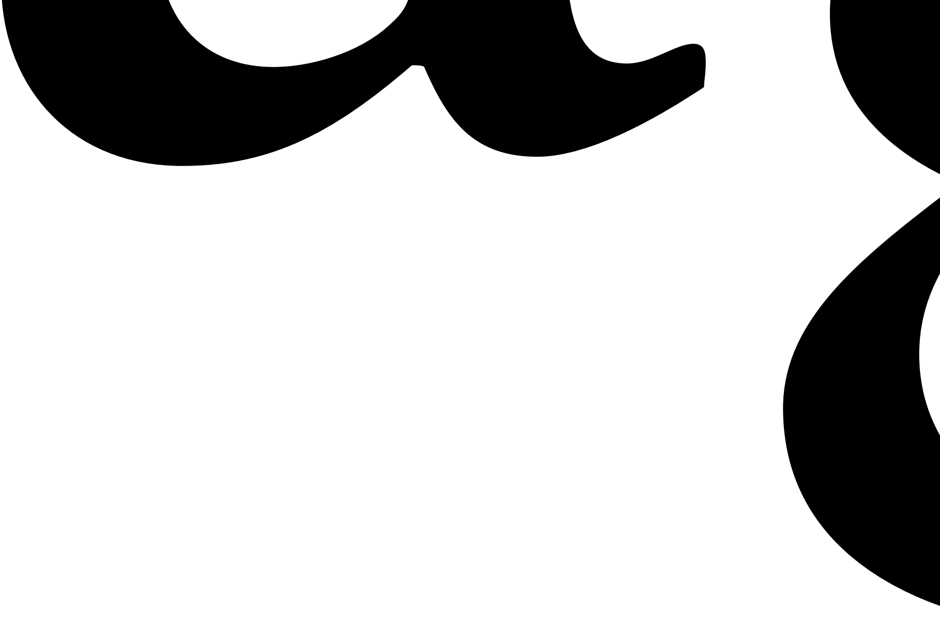
Dazzling bark

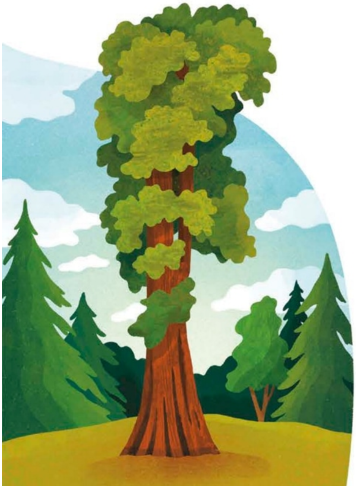
The rainbow eucalyptus has the most colorful trunk of any tree. Its outer bark peels away to reveal a bright green inner layer. This gradually changes color as it ages. Many dazzling shades appear, depending on how long each area of bark has been exposed to the air.





g

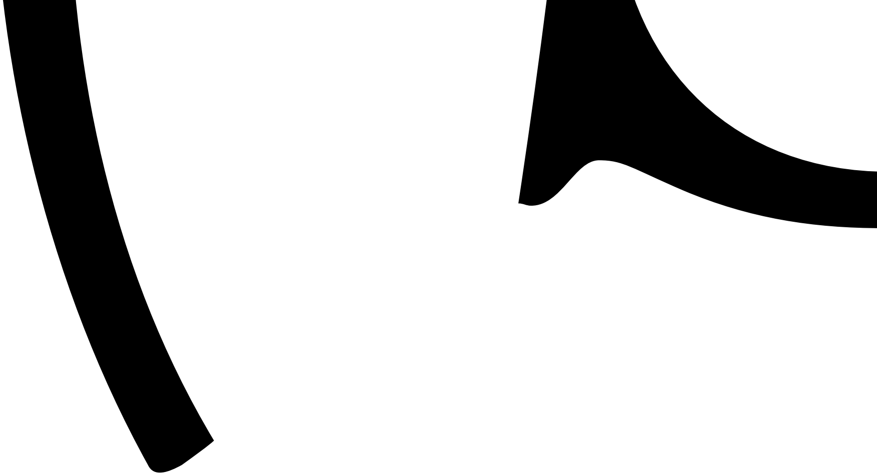




Giant sequoia

(Sequoiadendron giganteum)

Giant sequoias once grew in much of North America and Europe. Today, they live only in the Sierra Nevada Mountains in California—some are 3,000 years old.



G

m

E

th

in

3

T

S

a

(6

D

ru

d

W

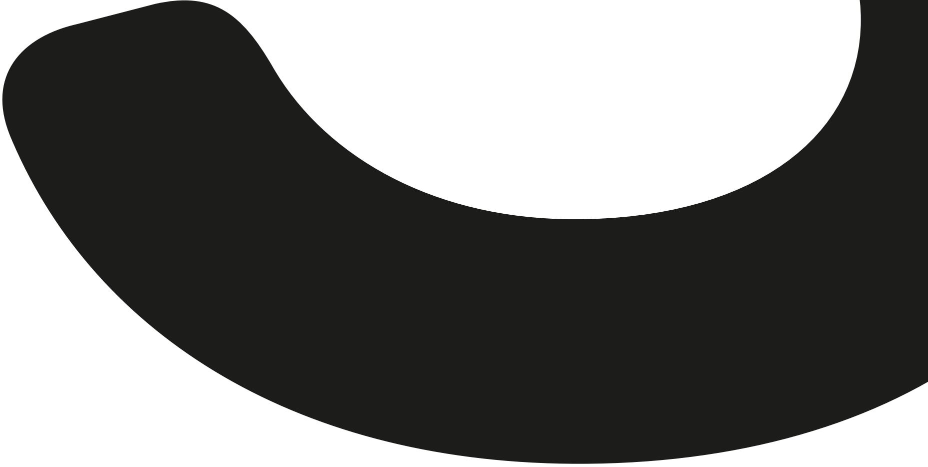
a

th

a

a

a



D

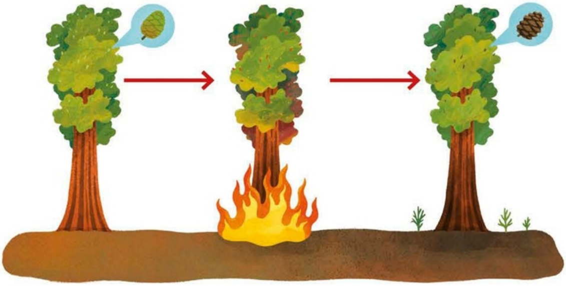
g

Se

ri

th

Giant sequoia



Helped by fire

The cones of giant sequoias take around two years to mature. During a wildfire, heat dries the ripe cones, so they split and drop their seeds. Ash from the fire is fertilizer for the seedlings, which thrive in the burned-out clearings.

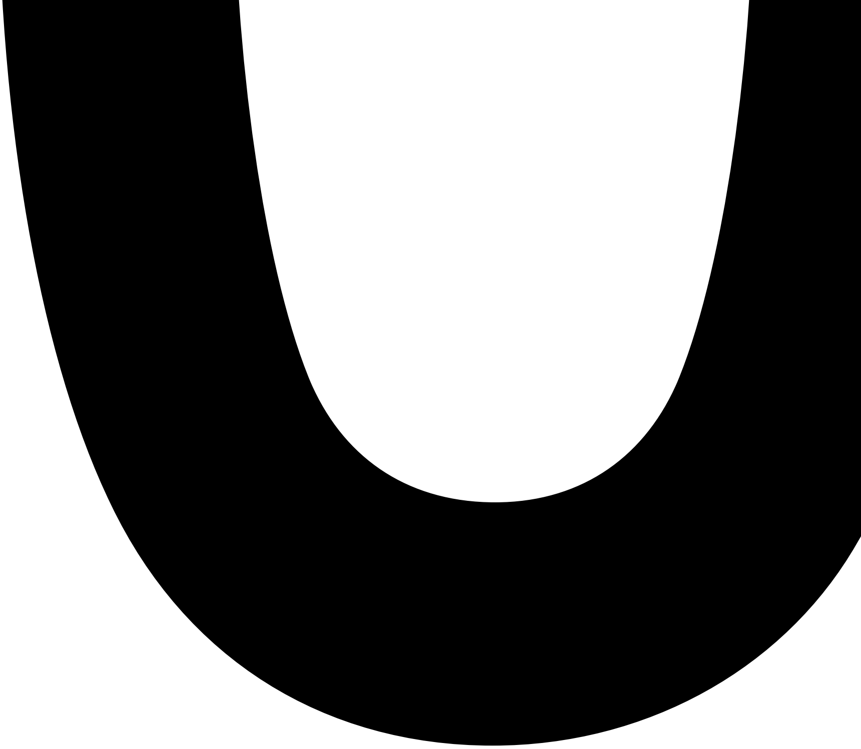
U

[redacted]

[redacted]

Q

U



[redacted]

T

ye

ri

fr

th

C

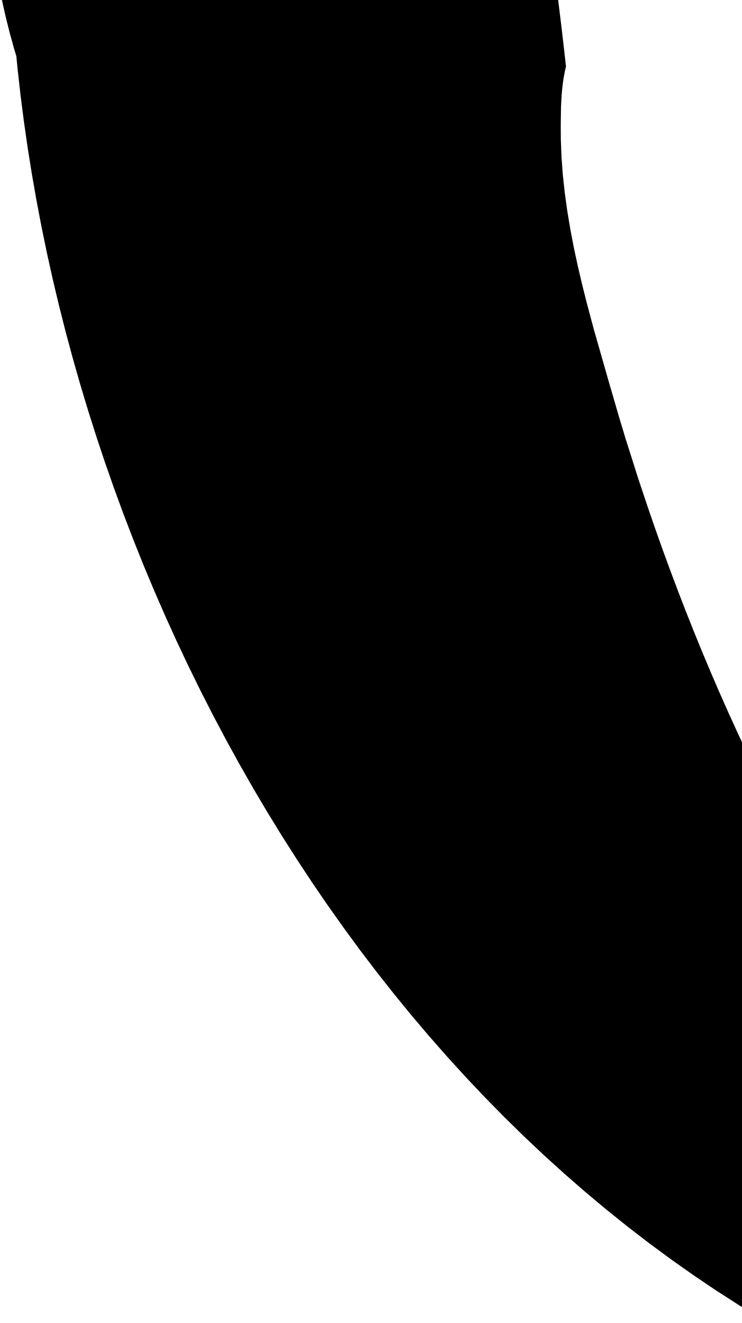
d

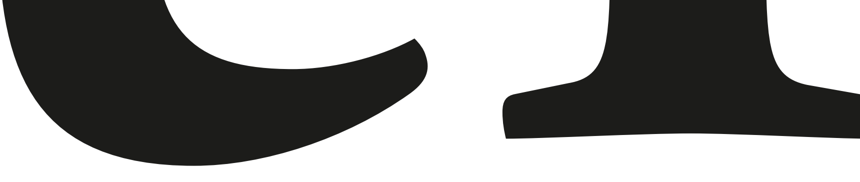
F

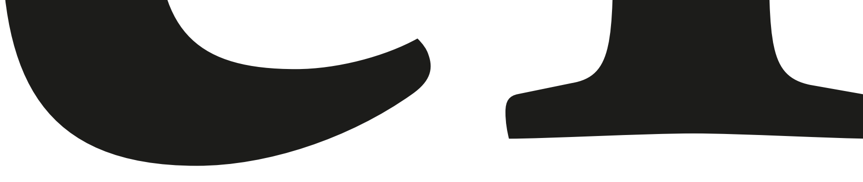
C

S

g







A

C

tr

SU

W

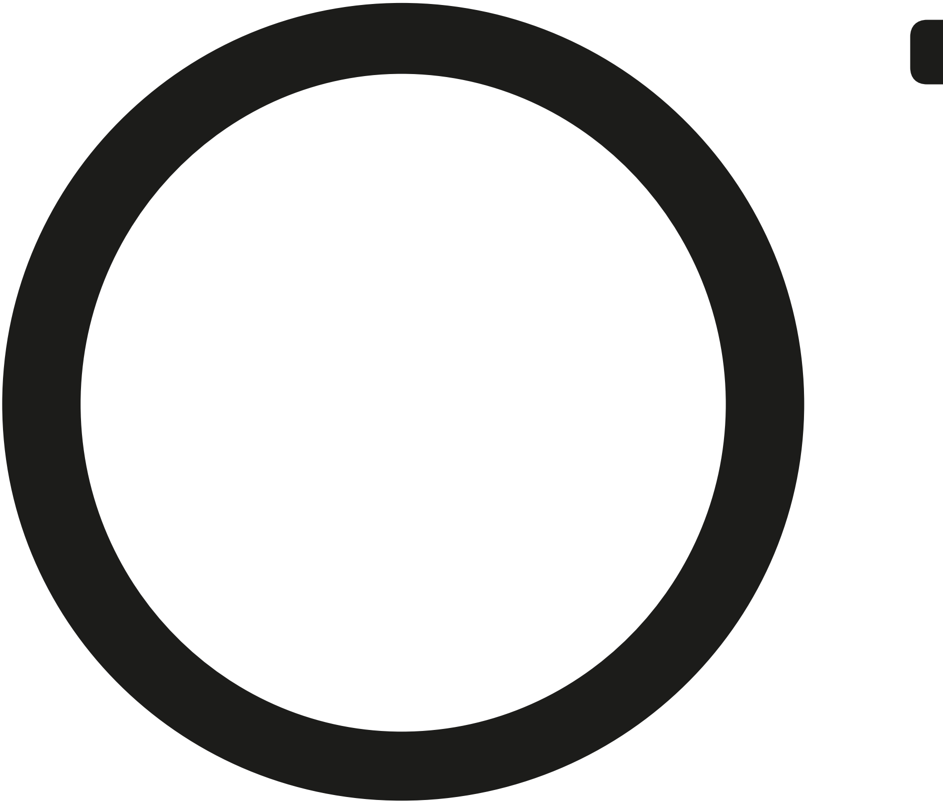
W

T

up

a

T



fo

h

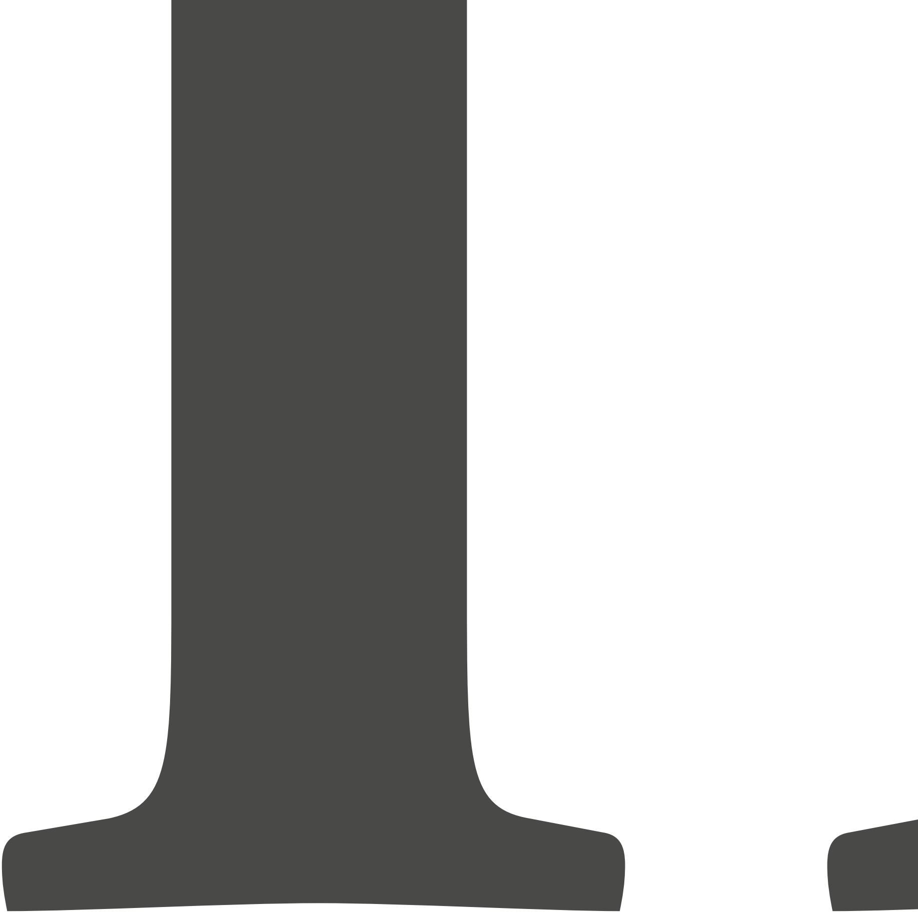
b

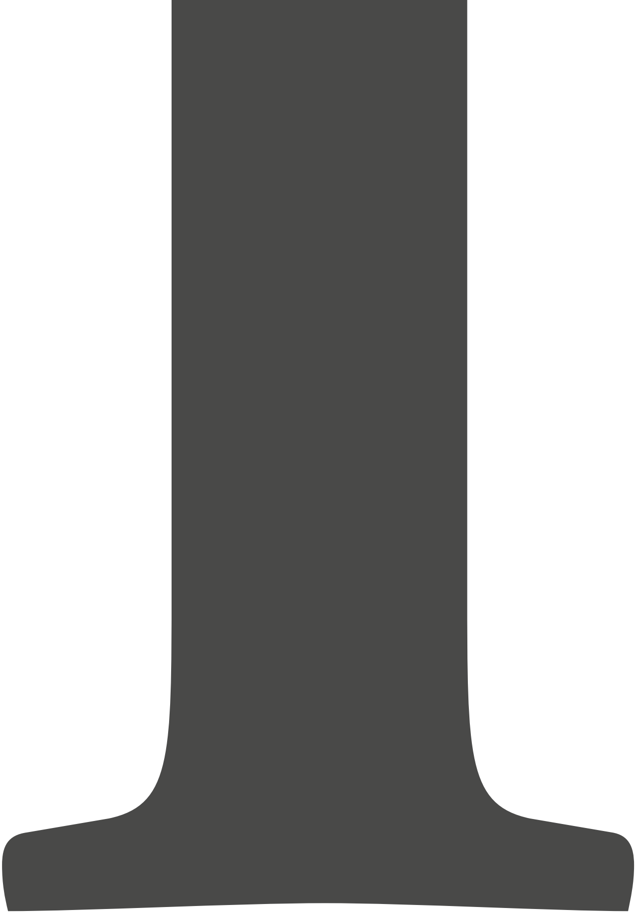
ye

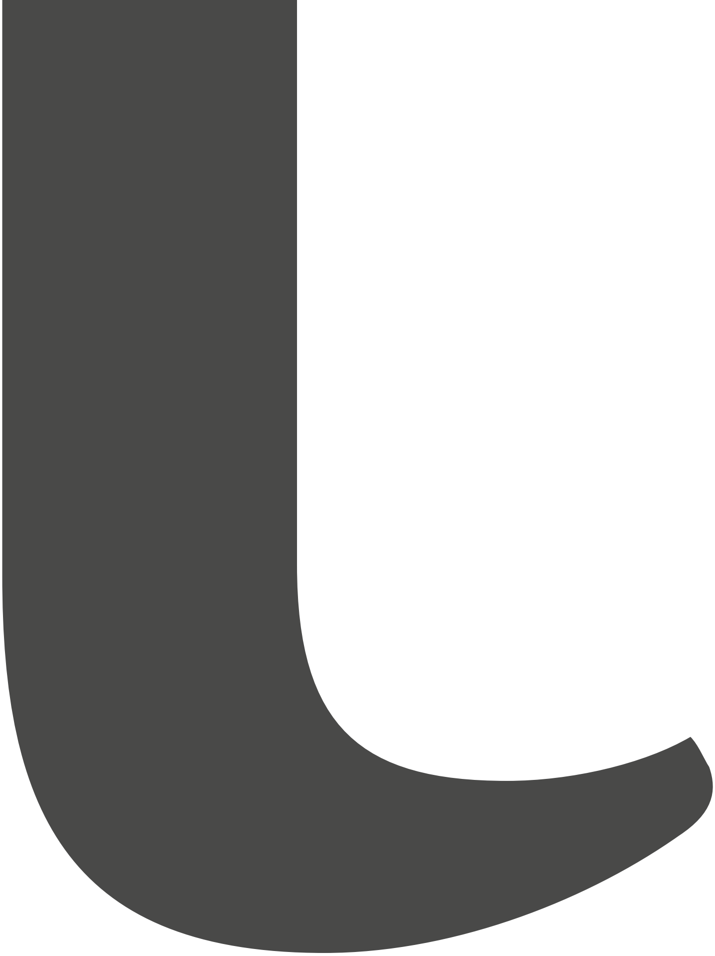
T

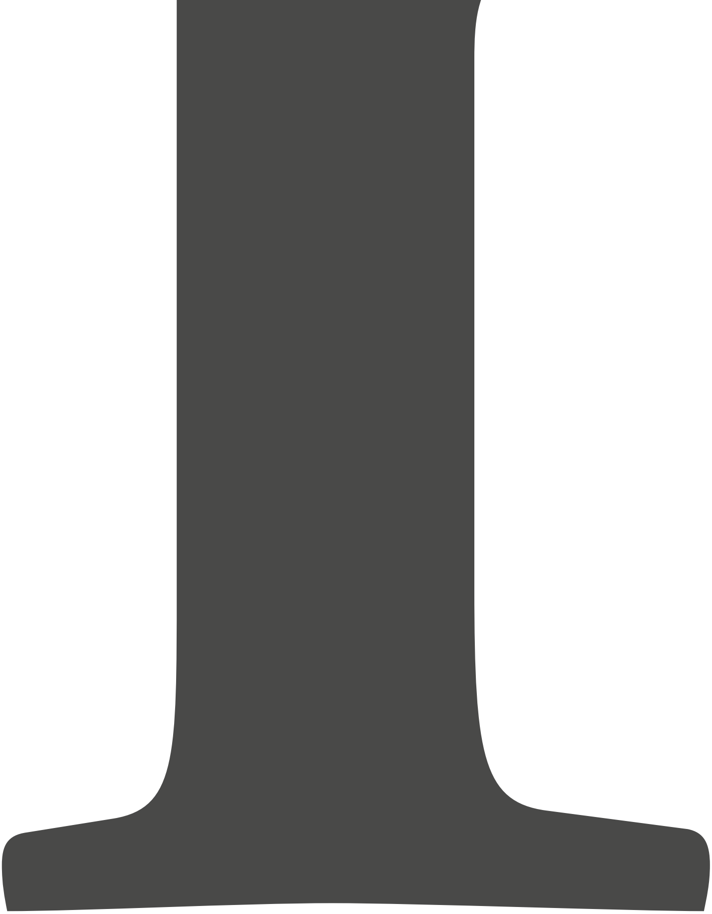
sp

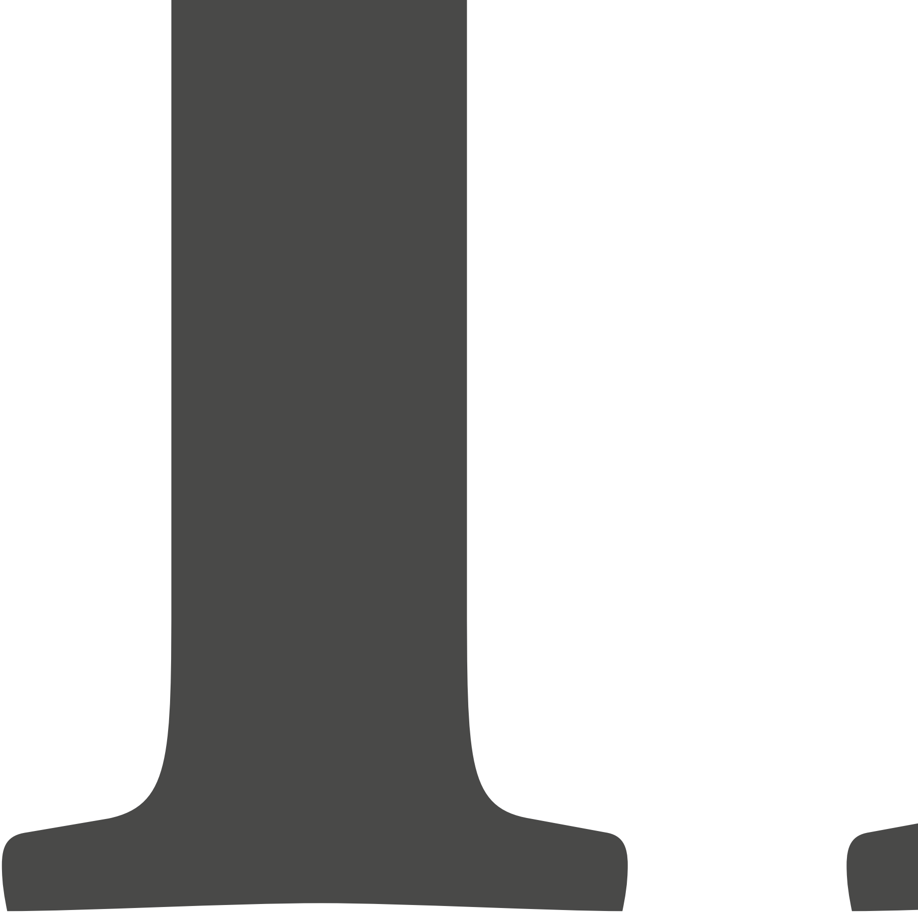
ro

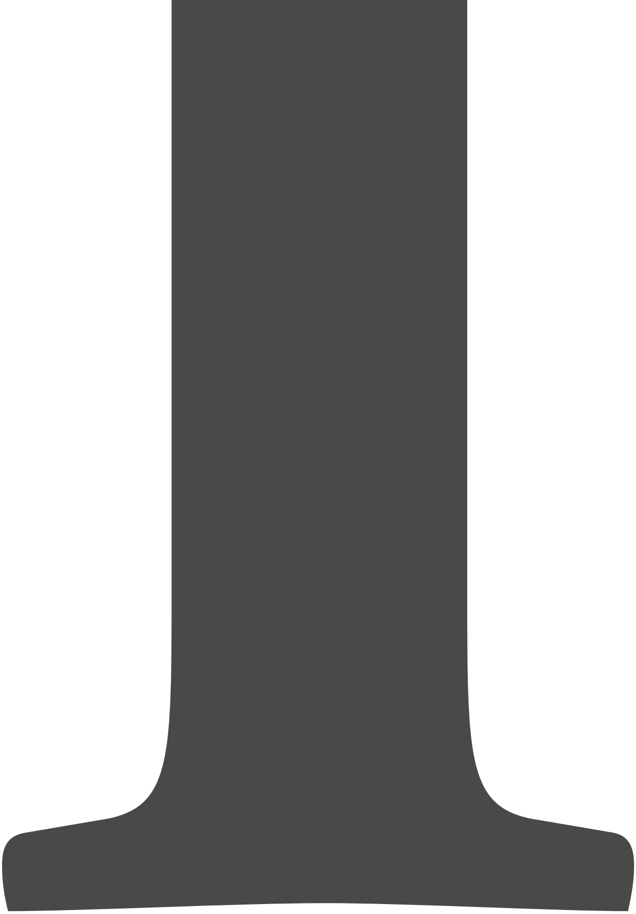




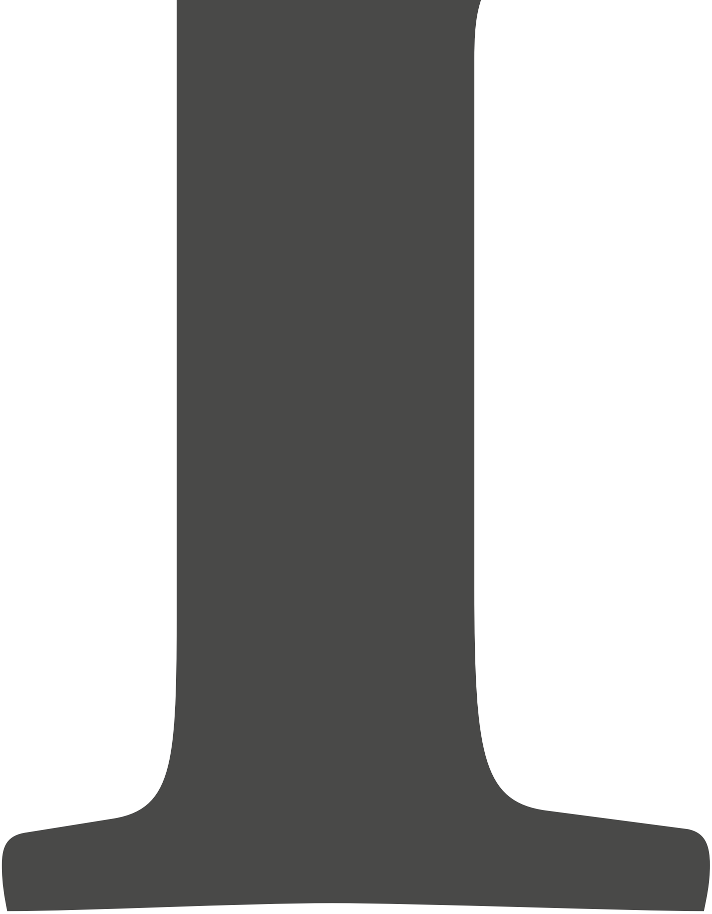




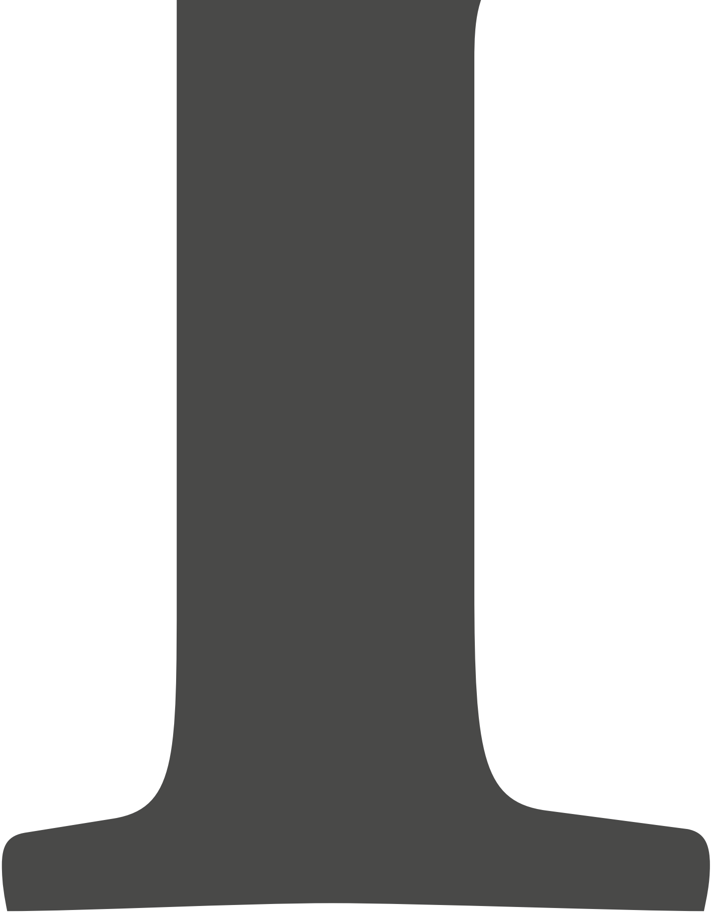


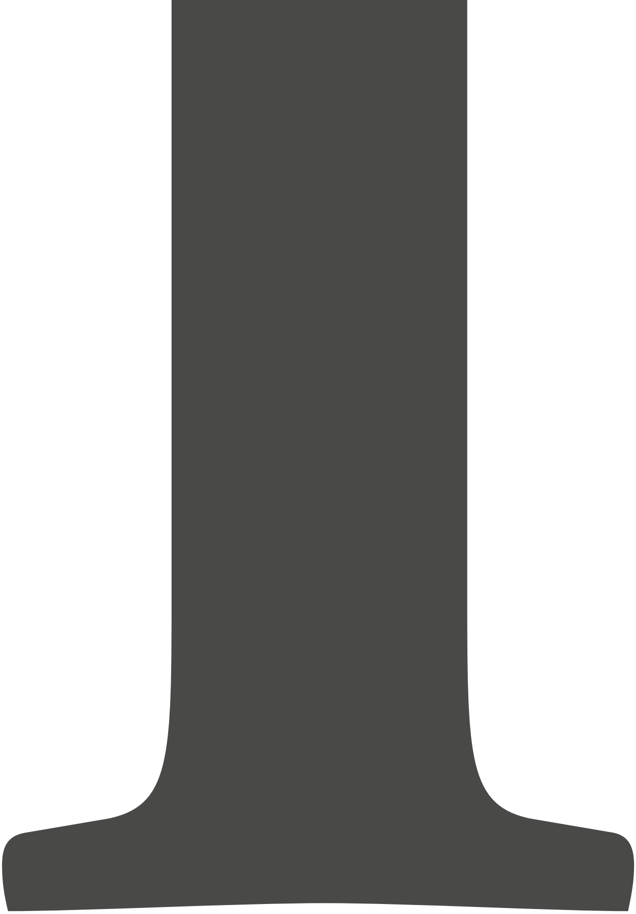


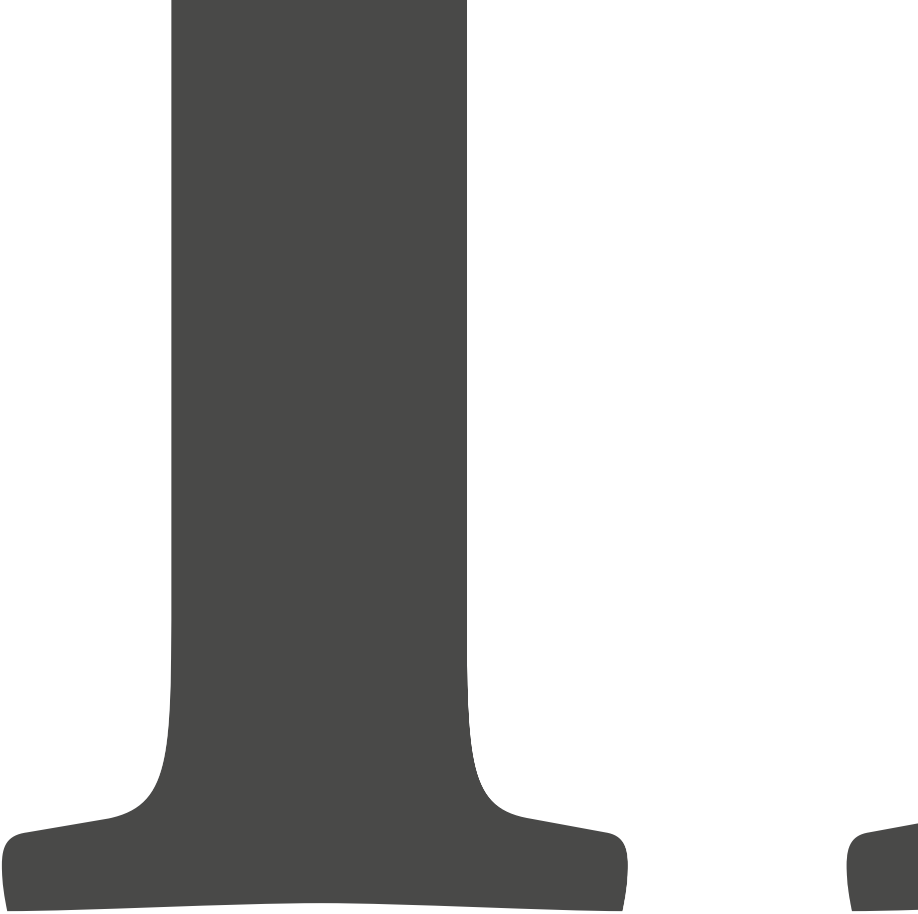
y

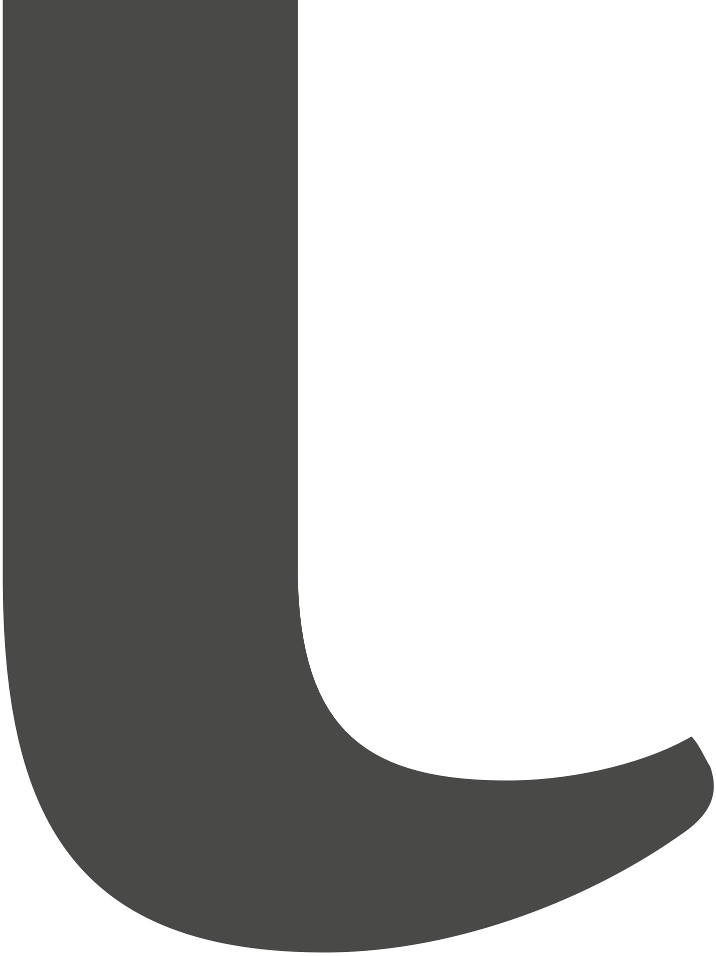


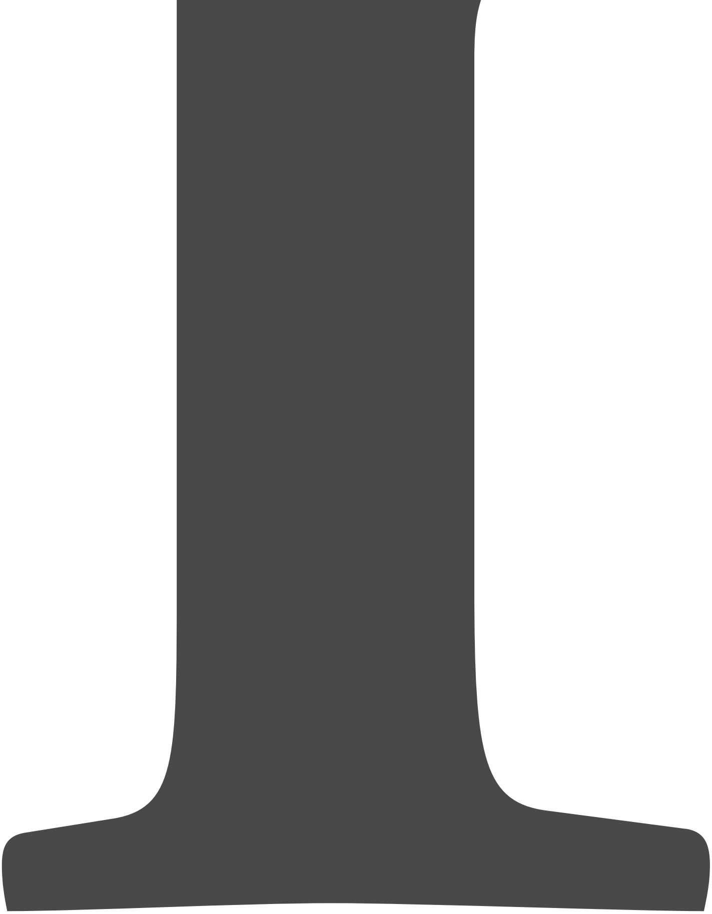
V

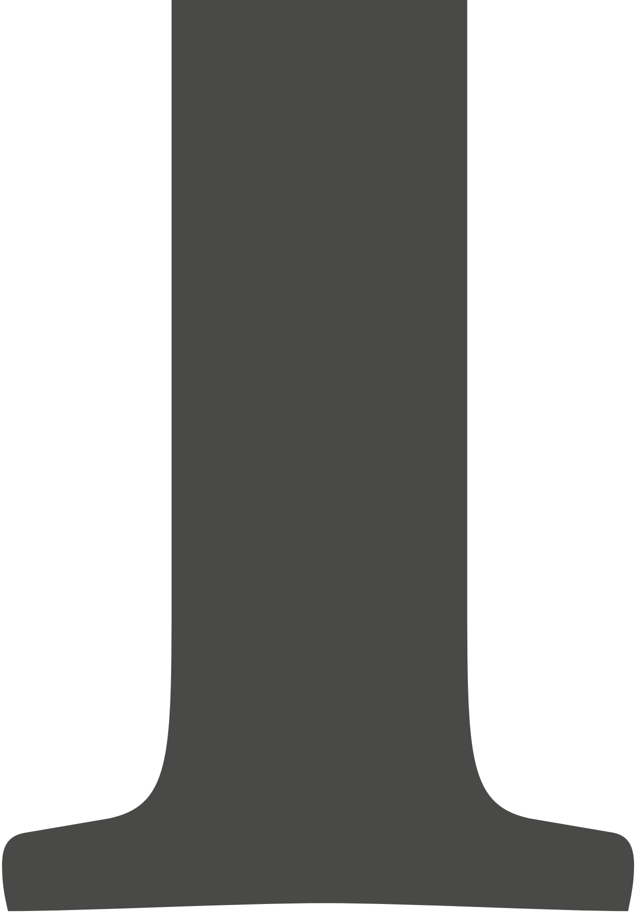


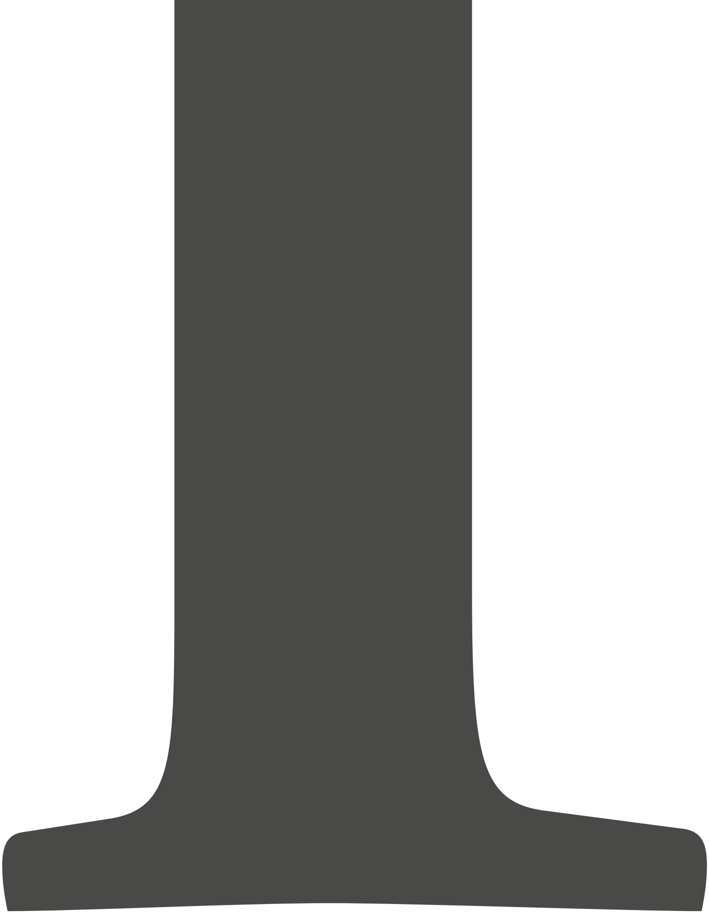


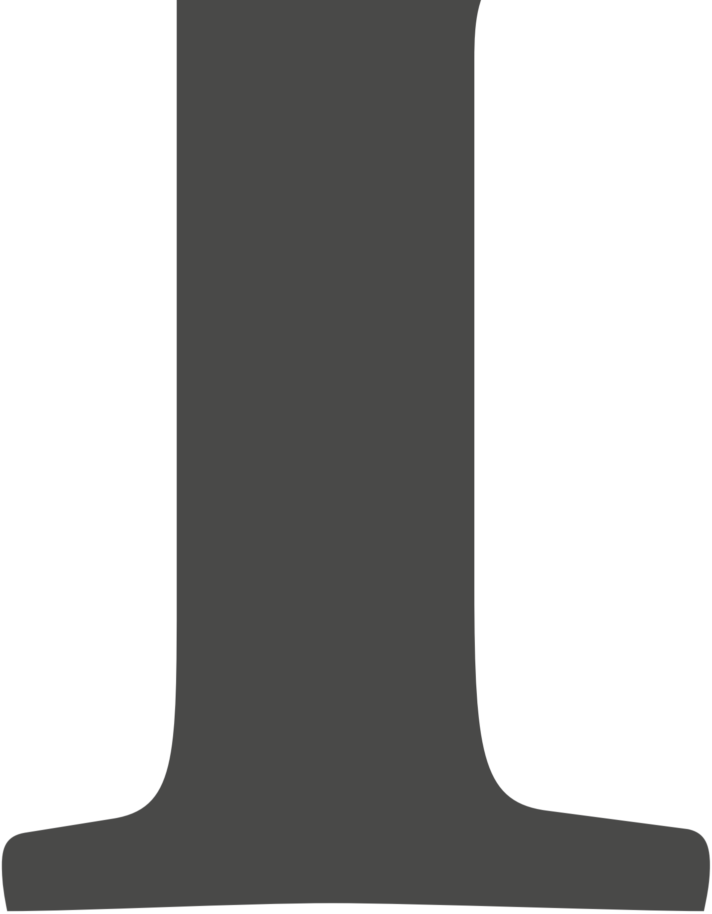


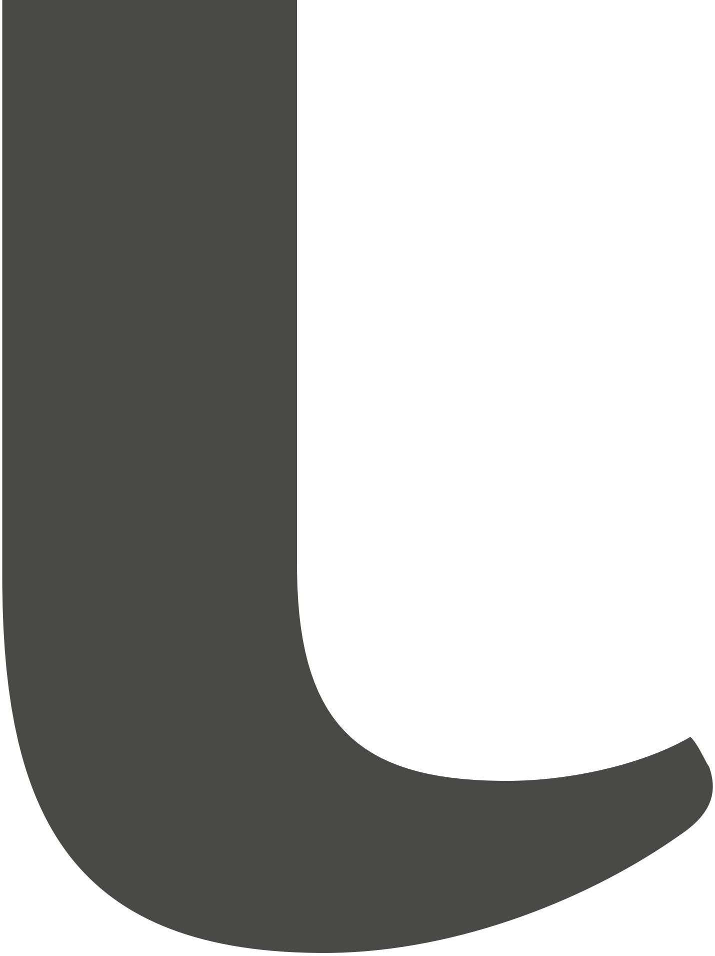


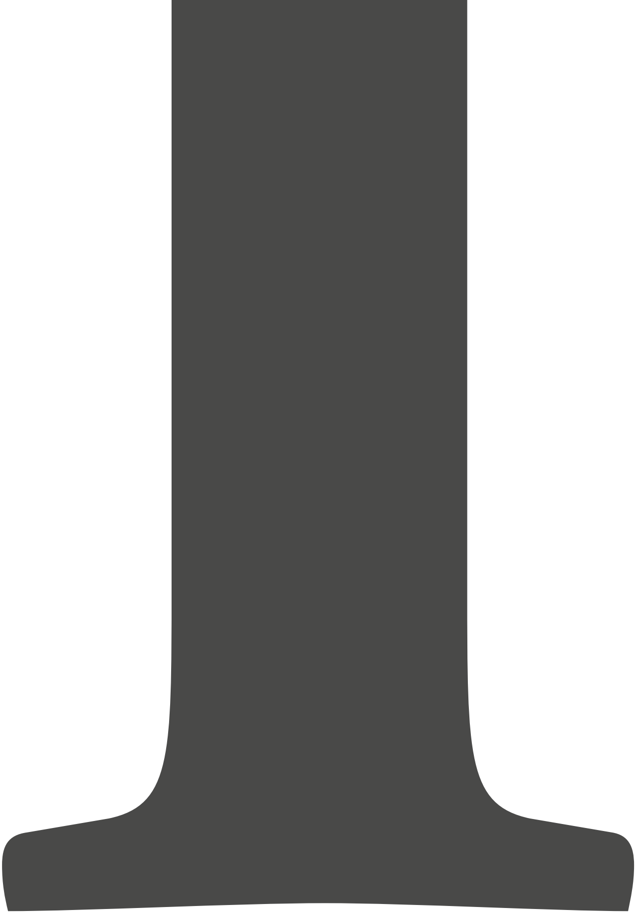


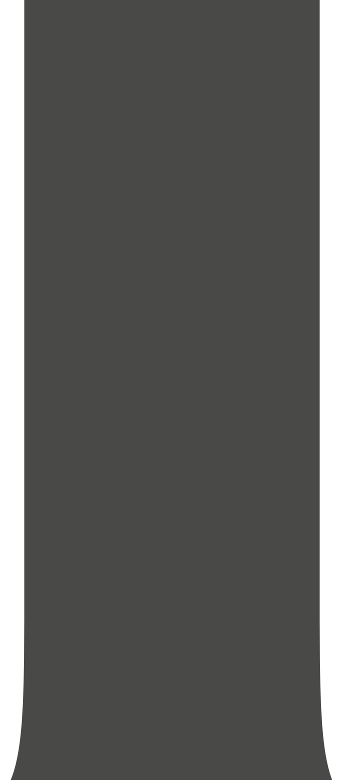


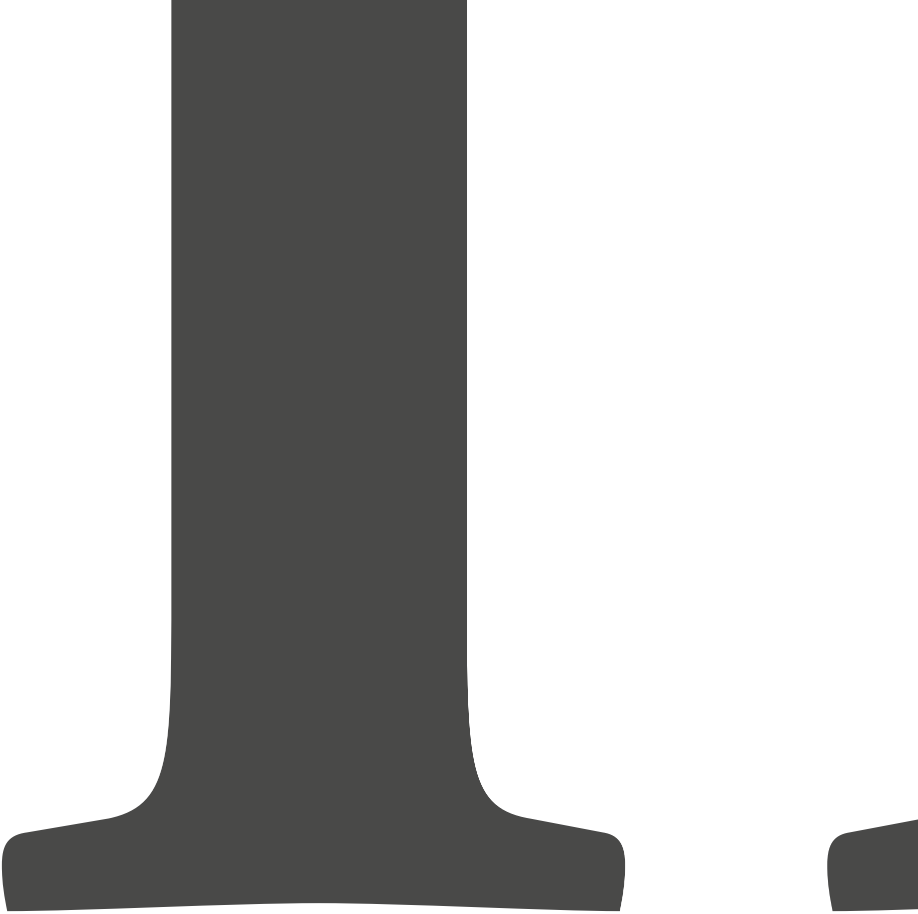


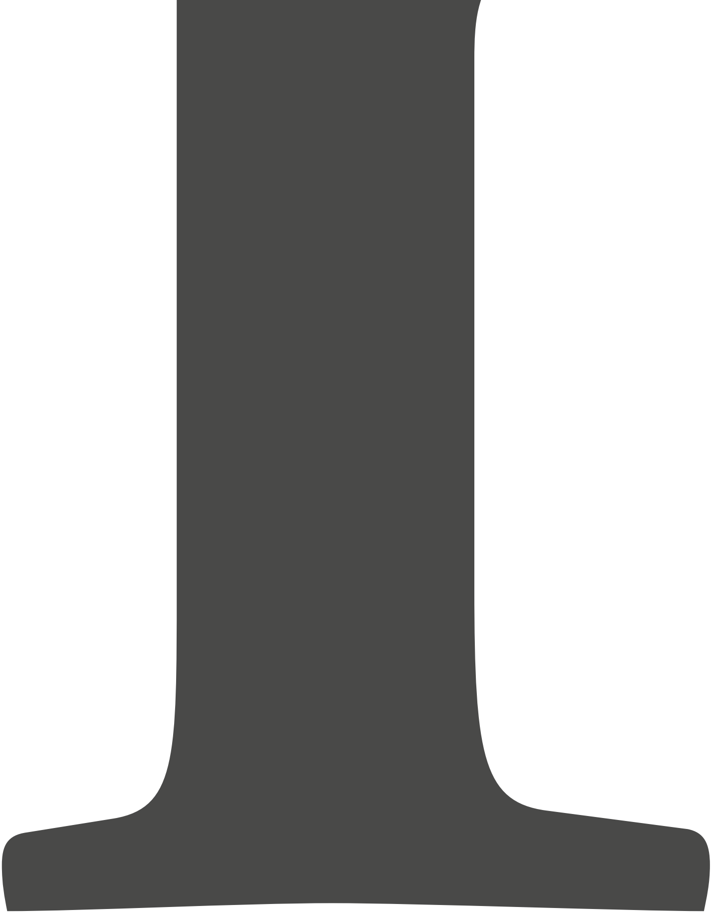


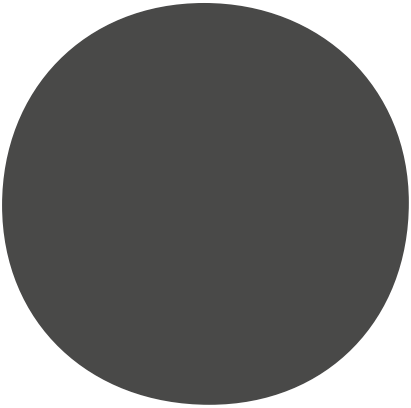




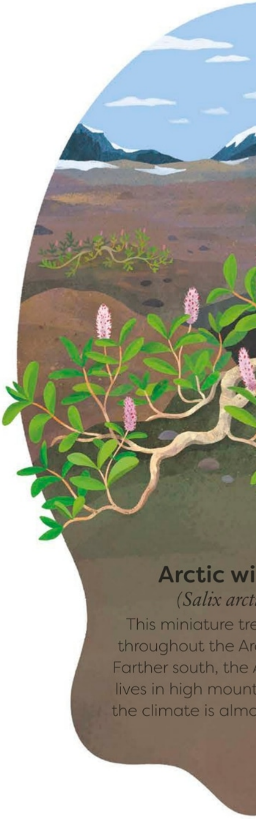








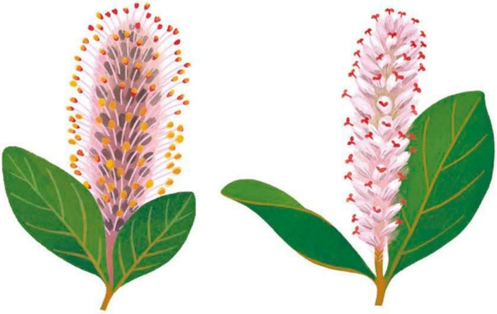
Arctic willow



Arctic wi

(Salix arct

This miniature tre
throughout the Ar
Farther south, the A
lives in high mount
the climate is almo



Colorful catkins

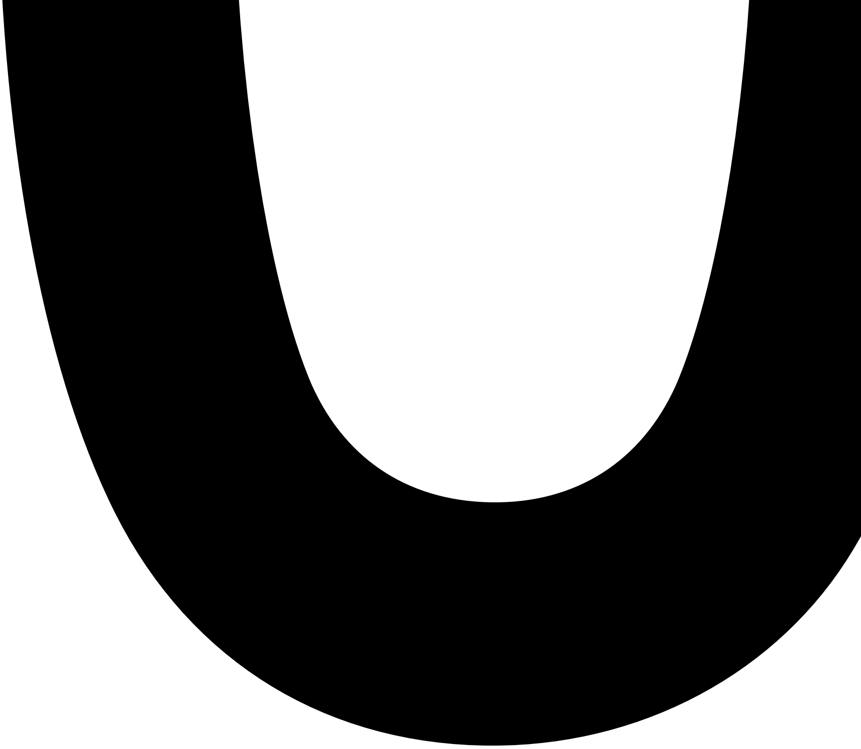
In summer, the Arctic willow is covered in fluffy bundles that look like small sticks of candyfloss. Thes are catkins and they contain the willow flowers, which are yellowish in male trees and red in female trees. Tiny flies pollinate them.

[redacted]

[redacted]

[redacted]

L



"

l

C

lik

a

W

in

tr

T

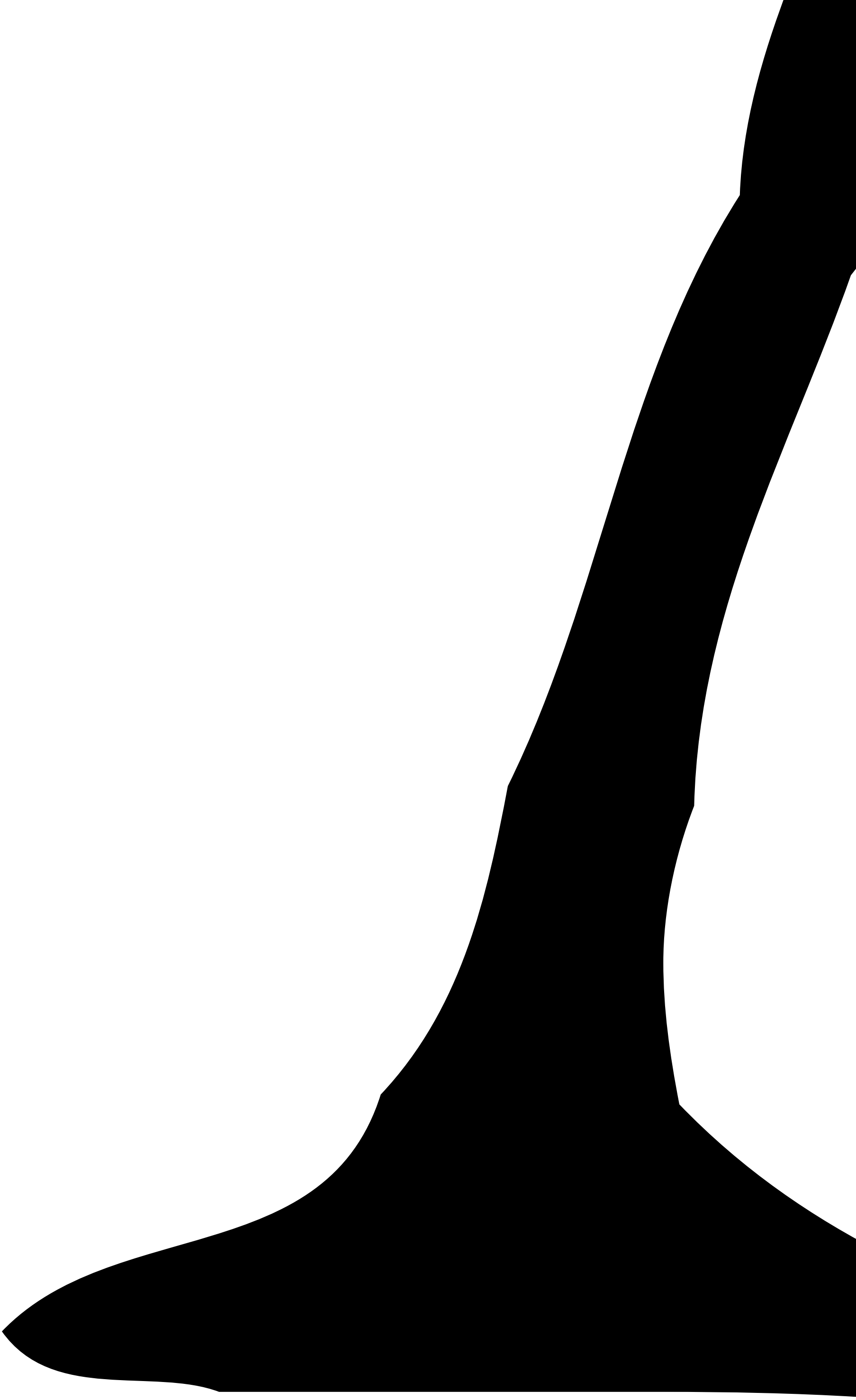
th

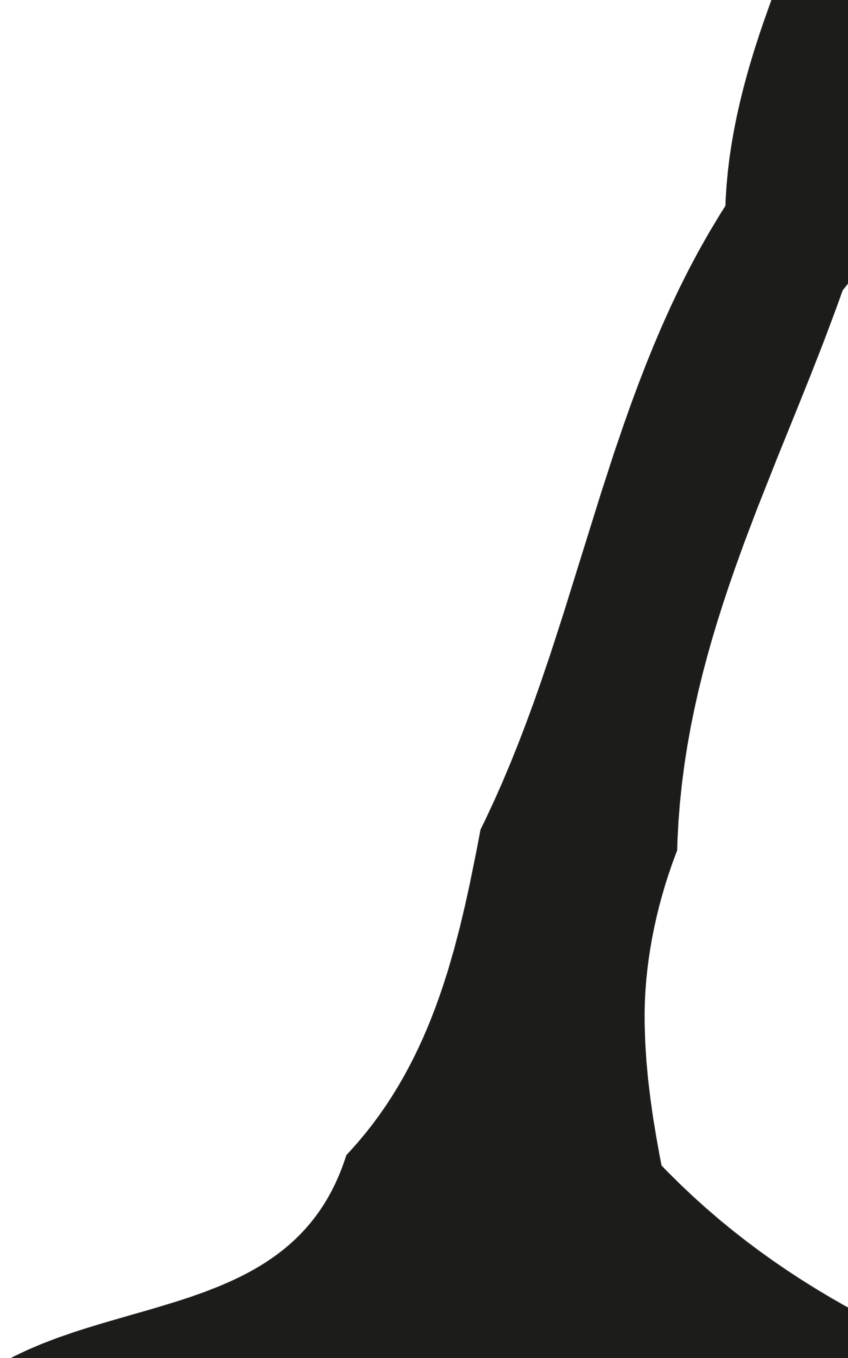
F

liv

th

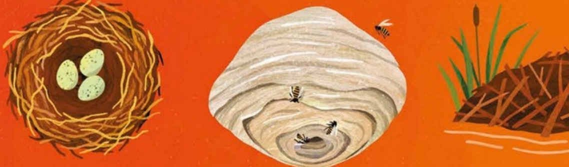
M





Animal architects

Many animals rely on trees for building materials, just like humans. Birds weave nests from sticks and leaves, wasps chew strips of wood to make paper for their nests, and beavers pull trunks and branches across rivers to form dams.



T

ti

p

fe

u

T

h

r

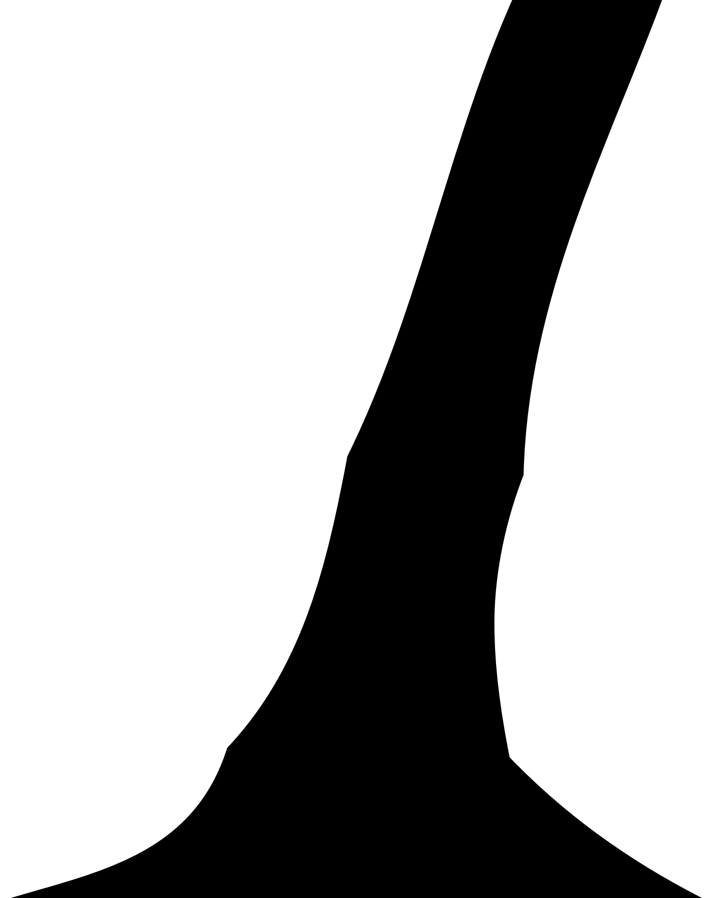
C

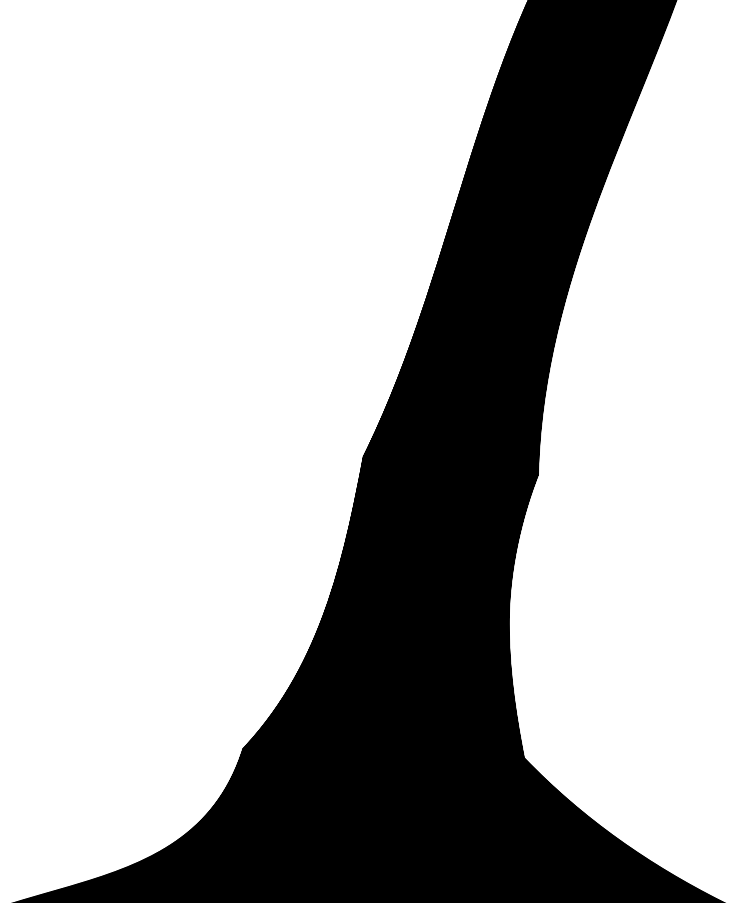
fu

B

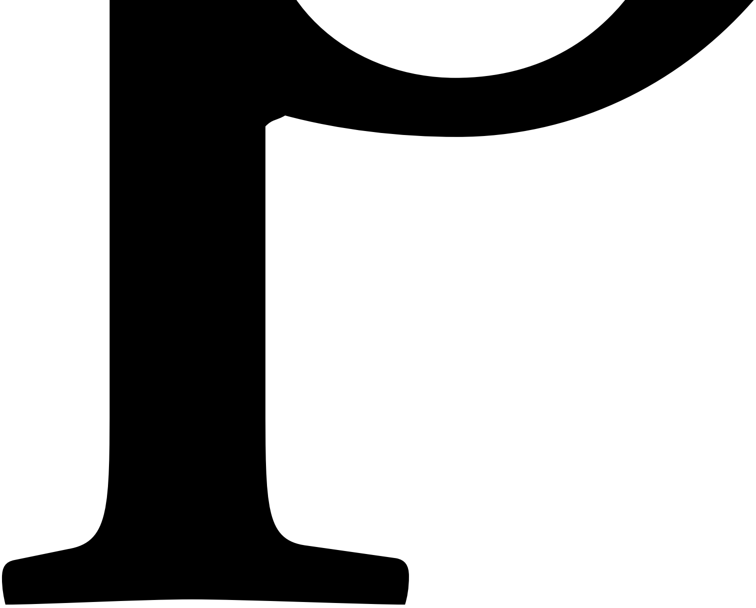
W

B





IV



R

lo

p

R

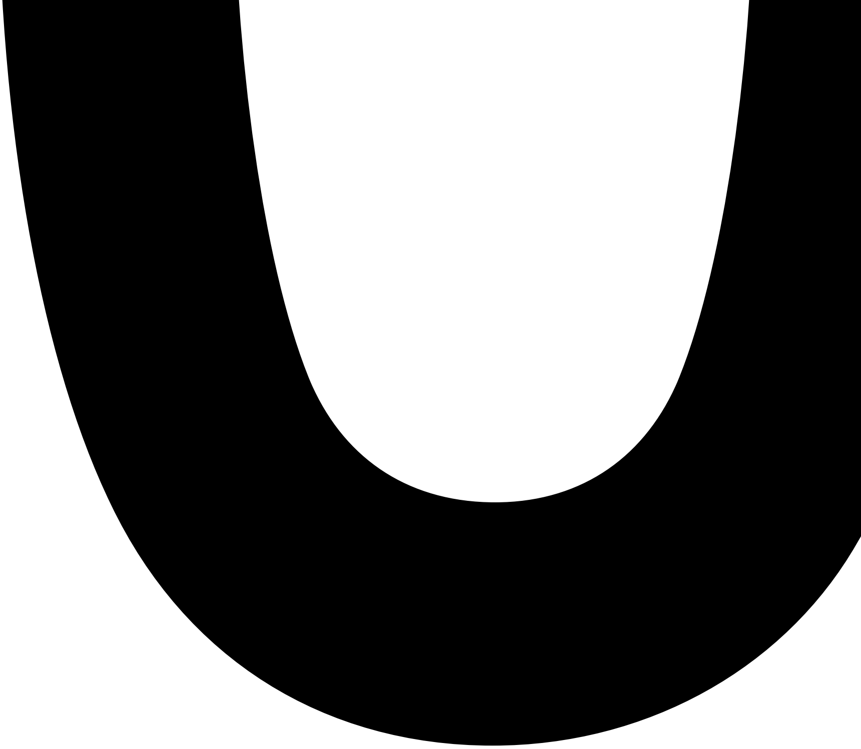
he

a

Made from trees

IV

L



IV

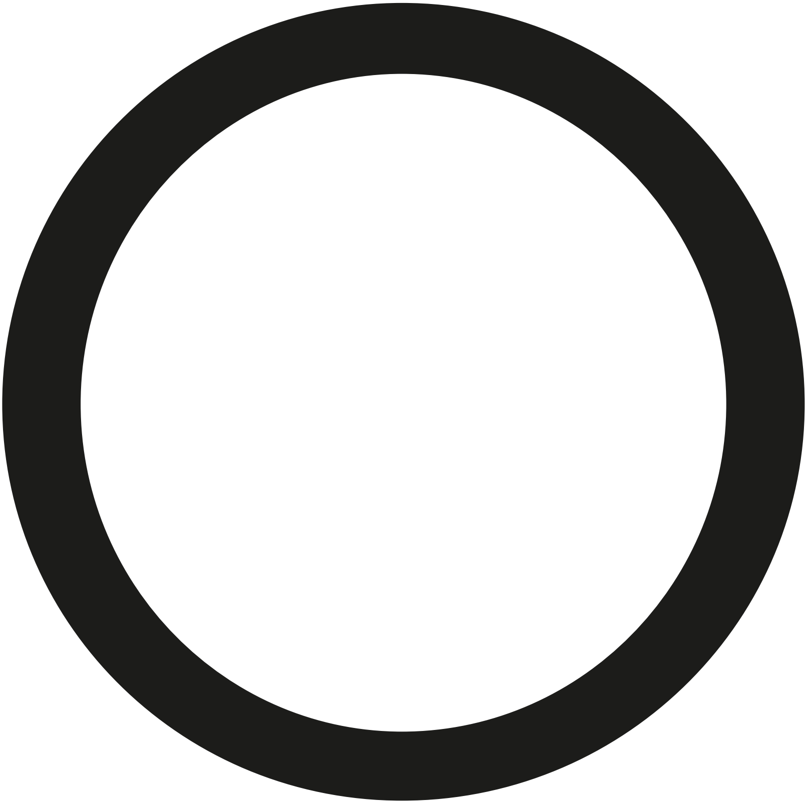
[redacted]

B

m

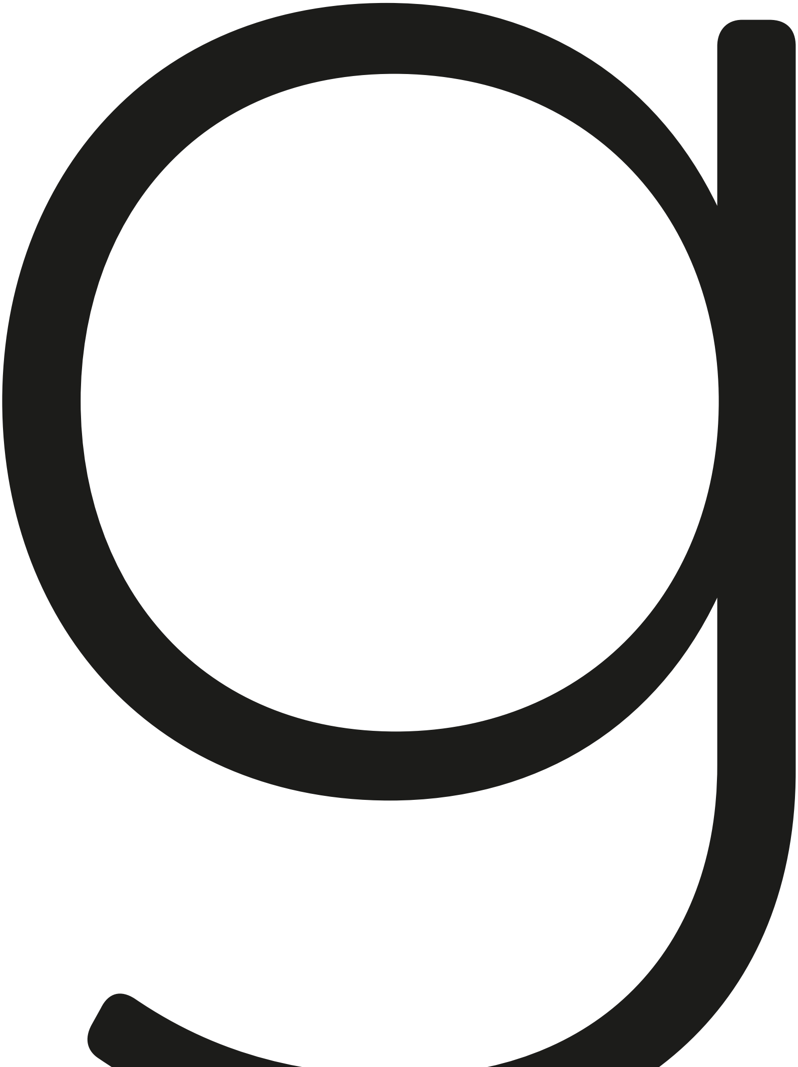
g

p



T

in



b

a

R

ru

tu

a

U

T

tr

q

t

d

m

T

W

W

th

st

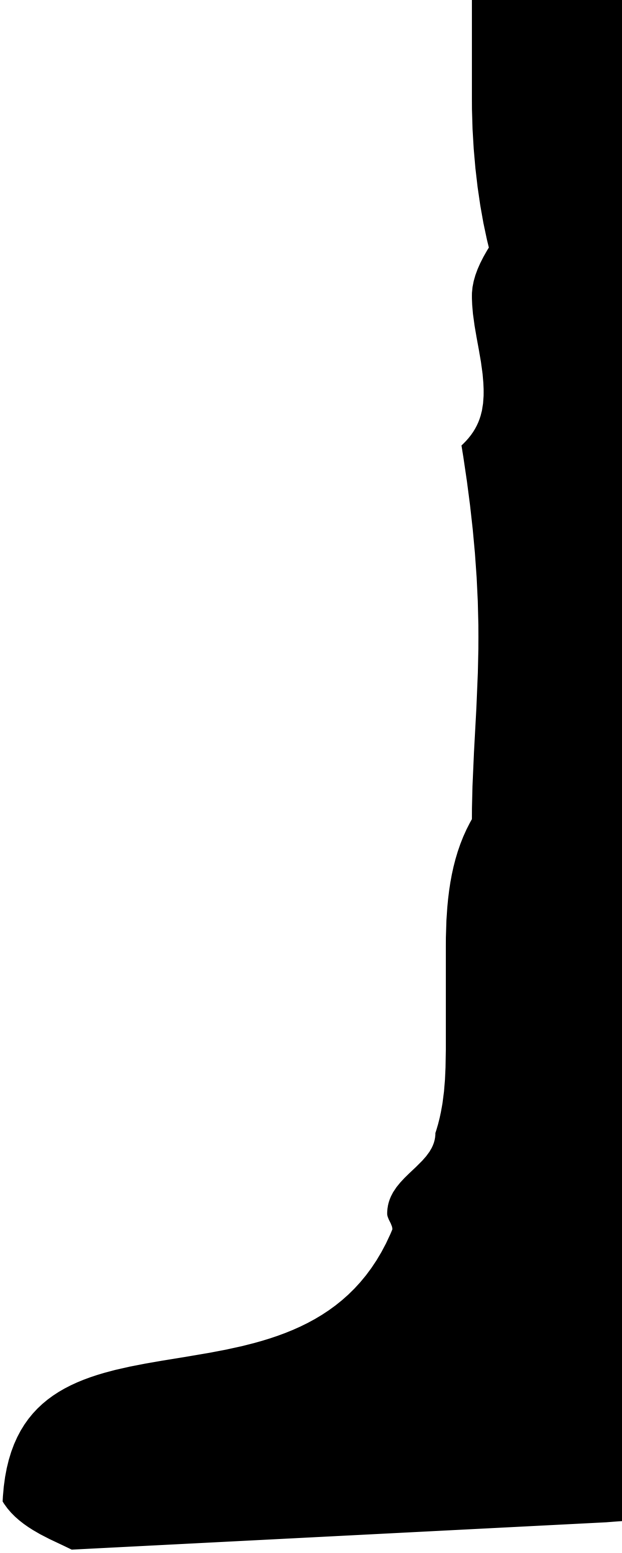
T

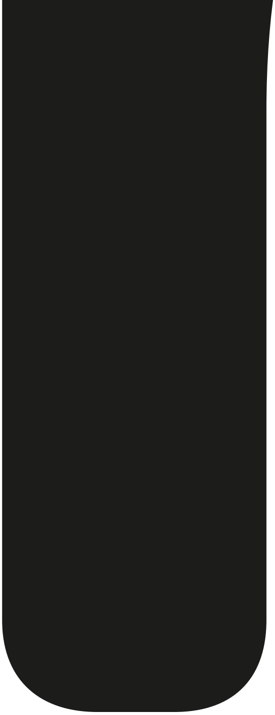
in

SU

W

a

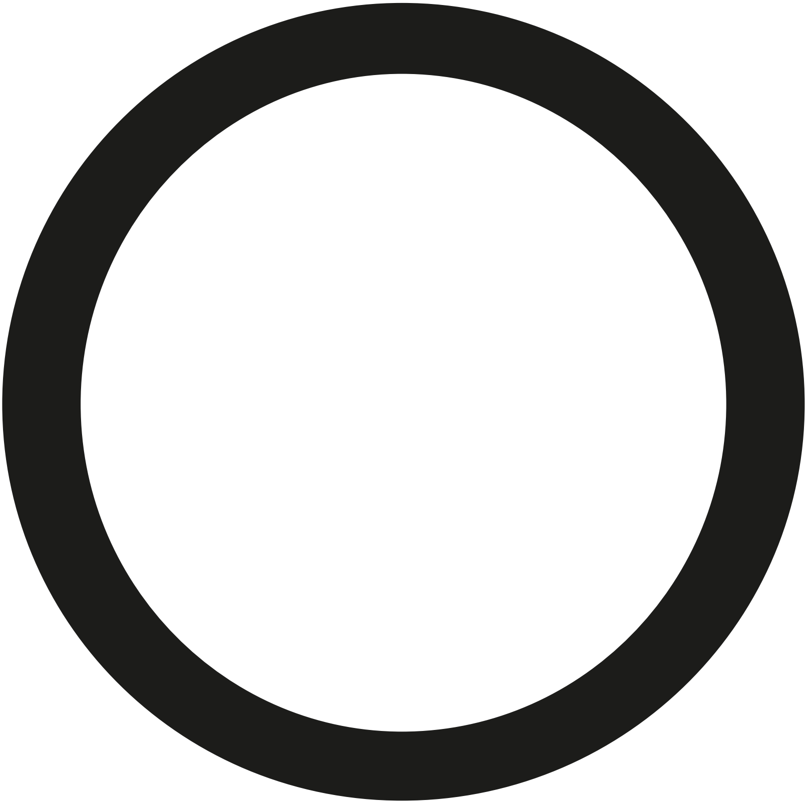




T

p

W



st

h

L

fr

b

F

a

fr

B

fo

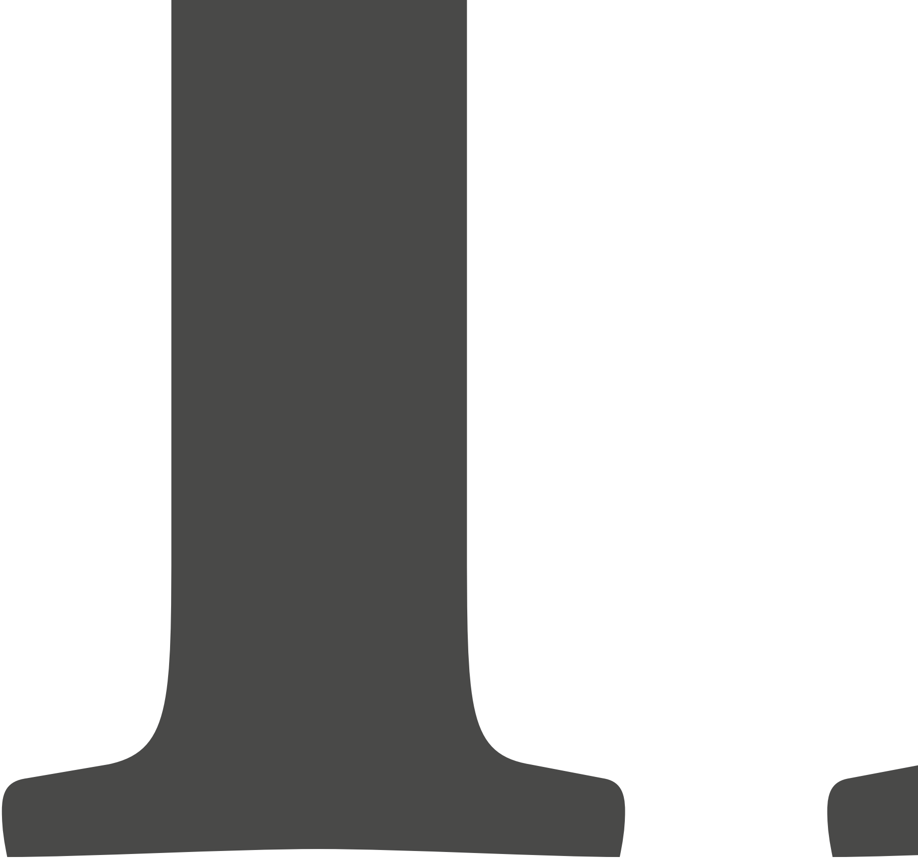
of

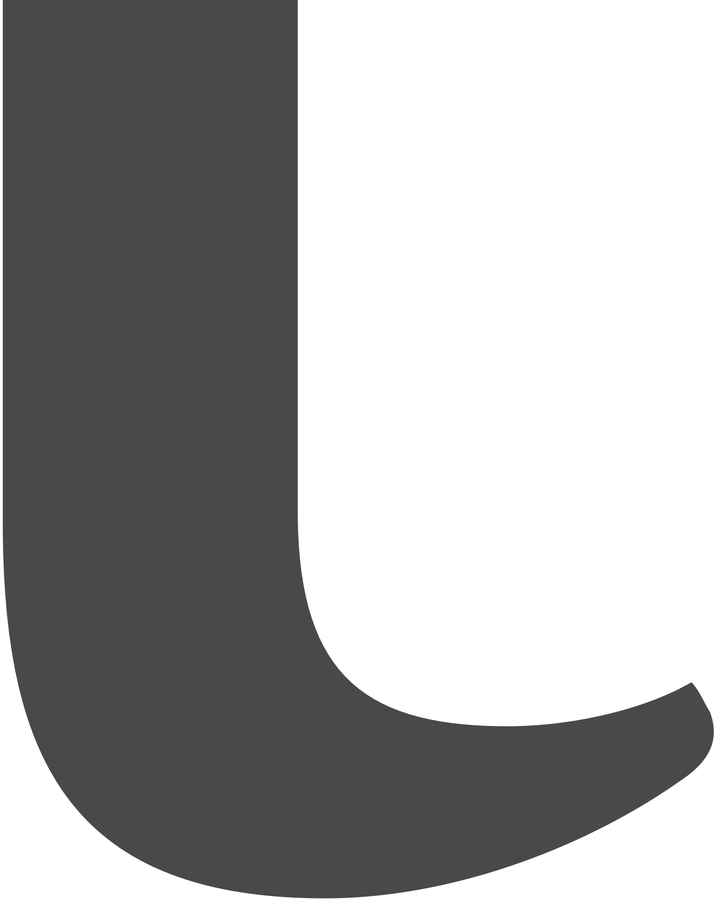
Th

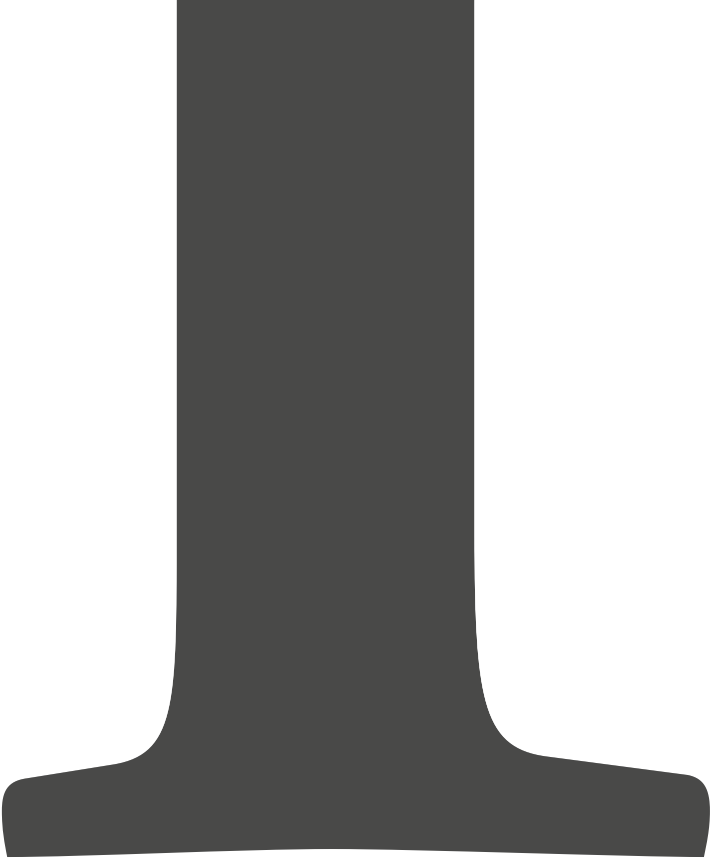
th

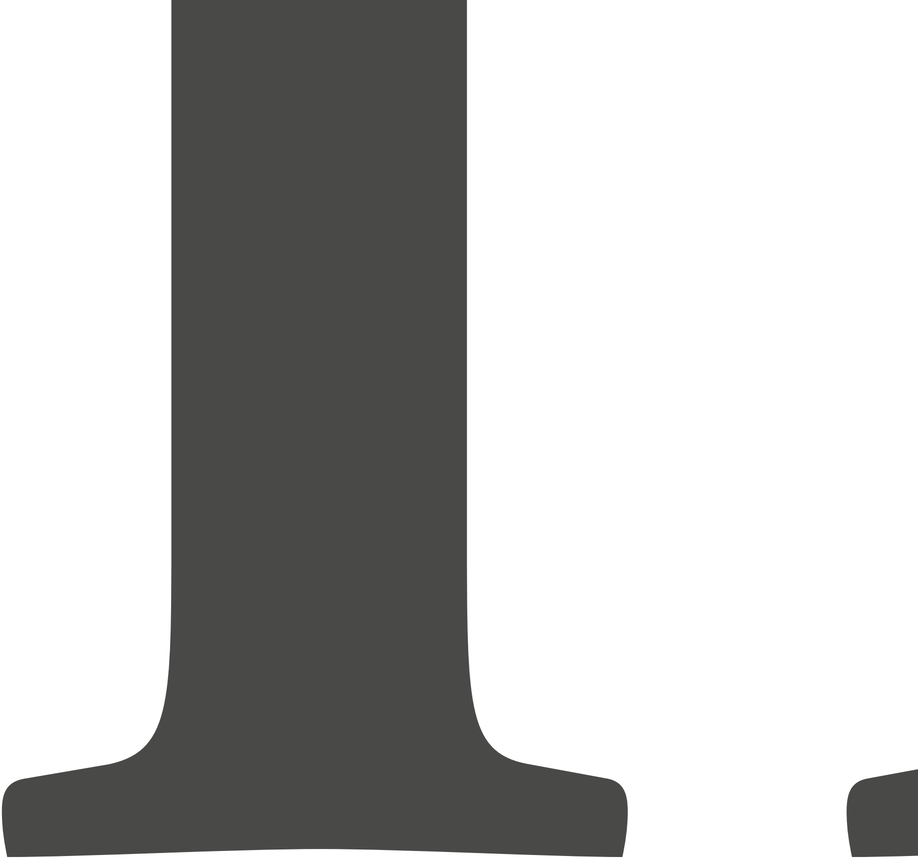
m

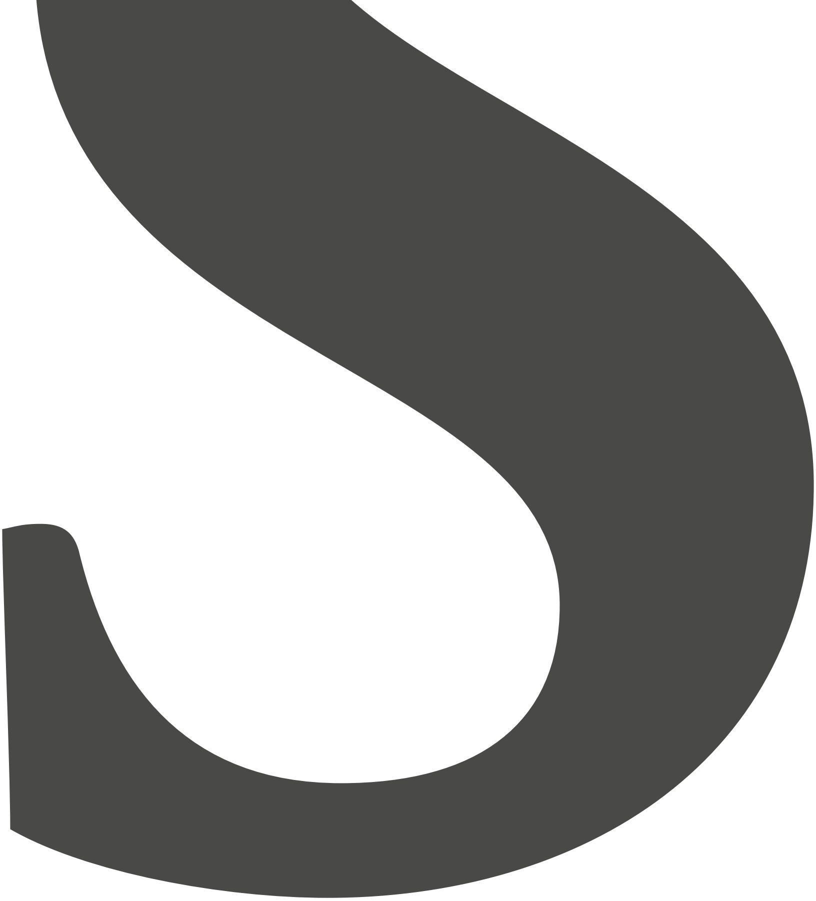
(3

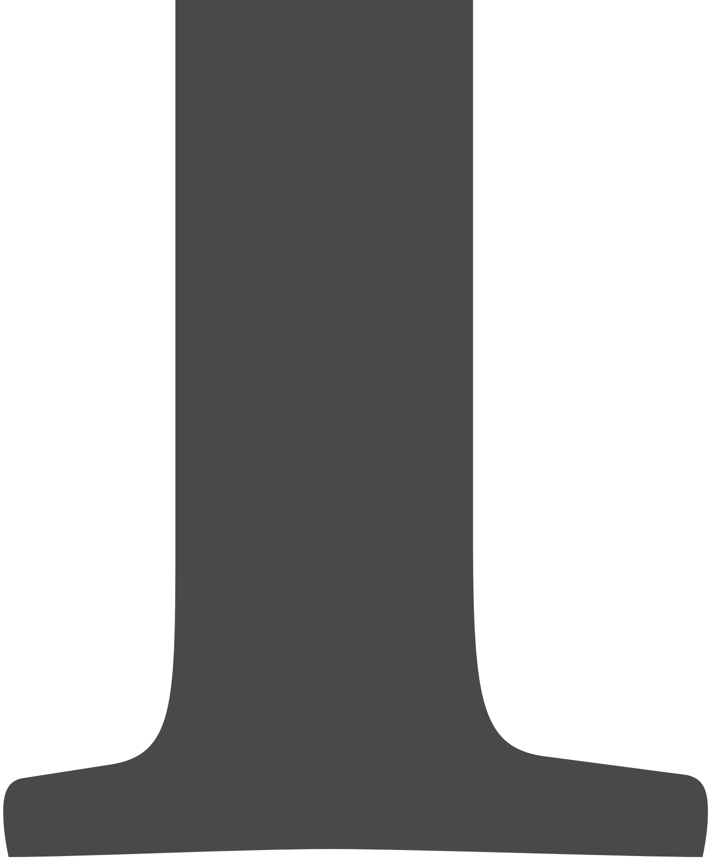


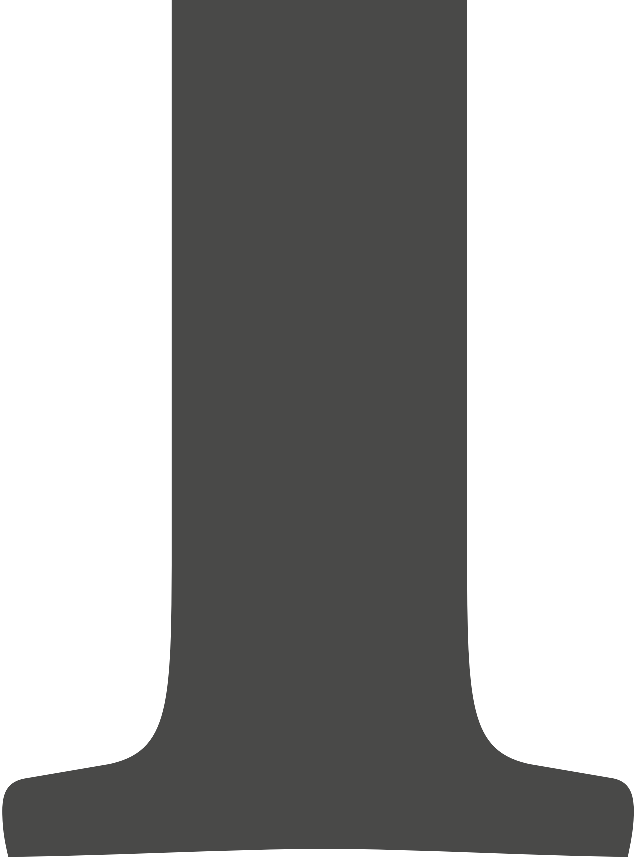




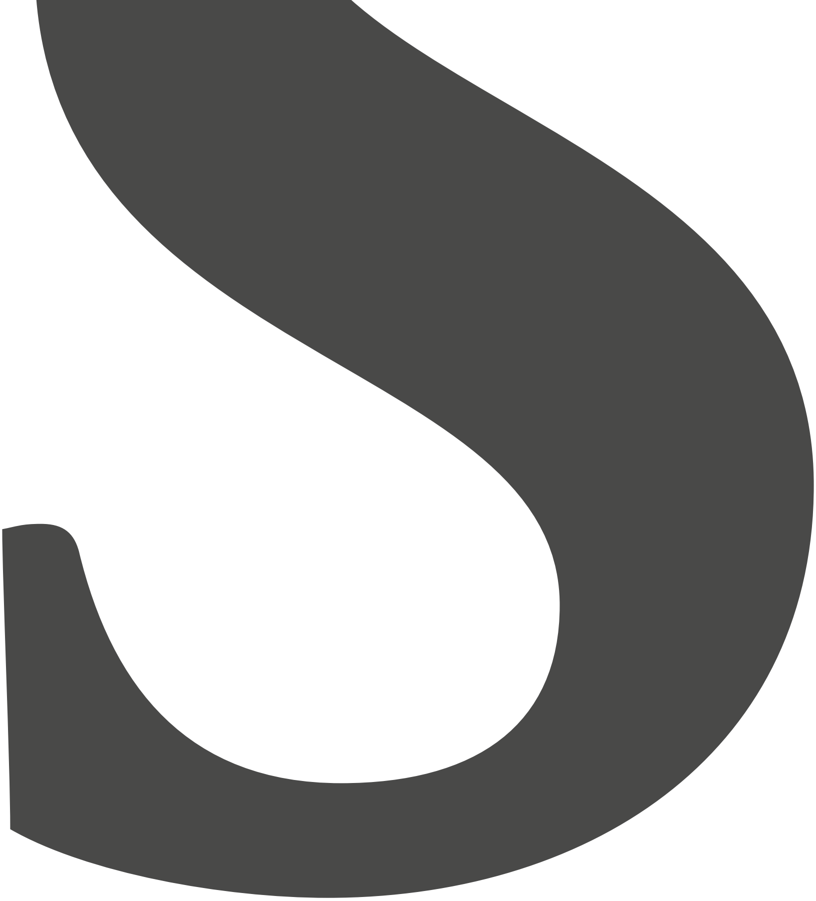


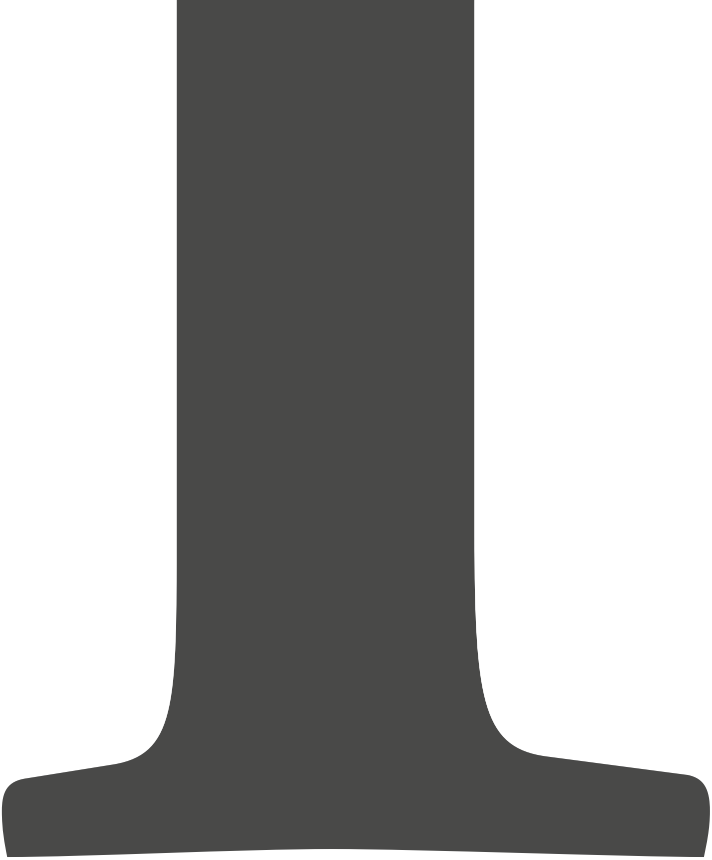


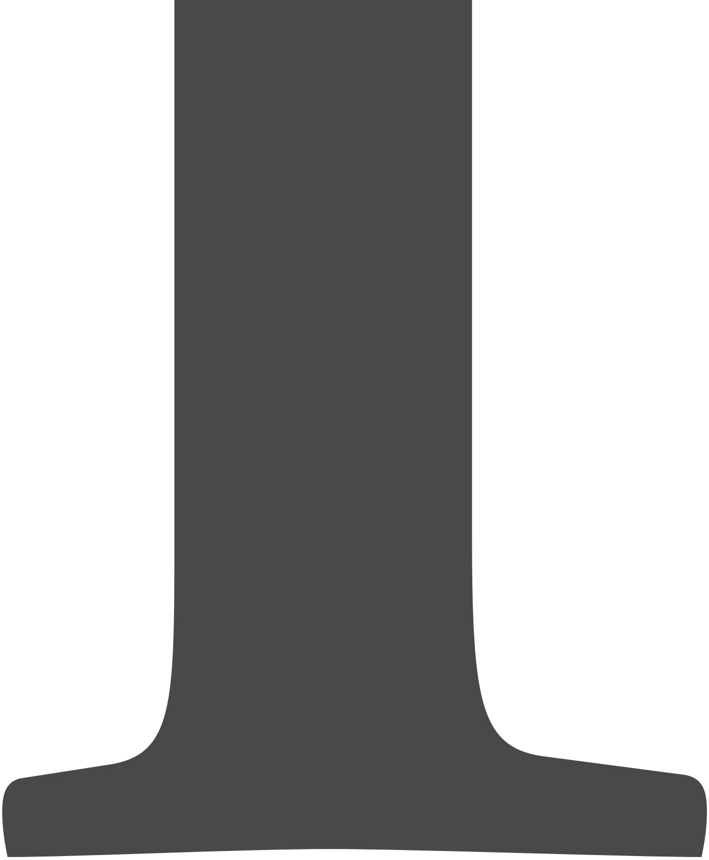


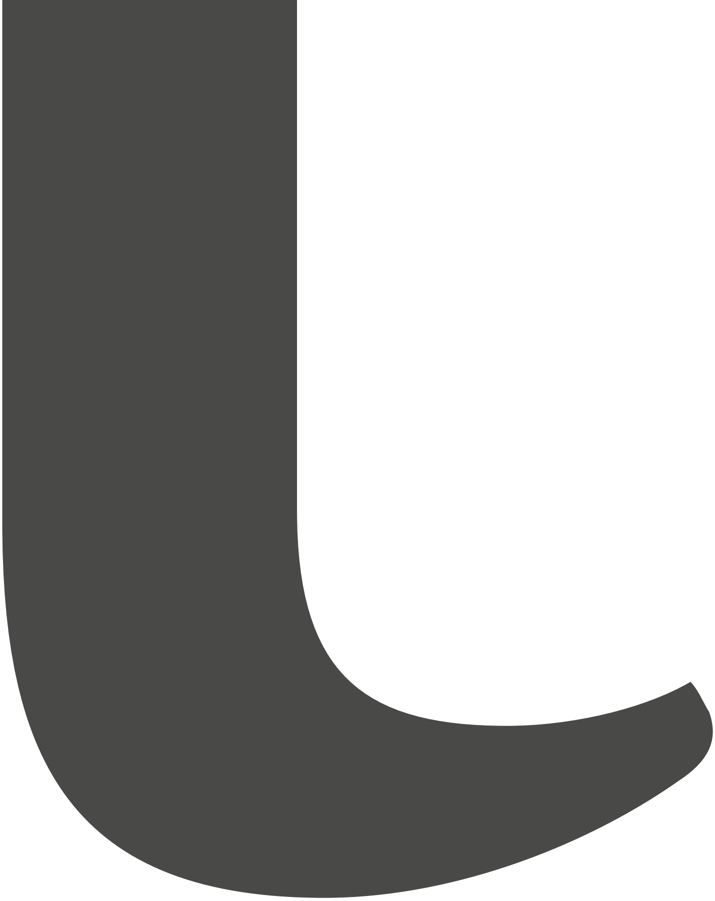


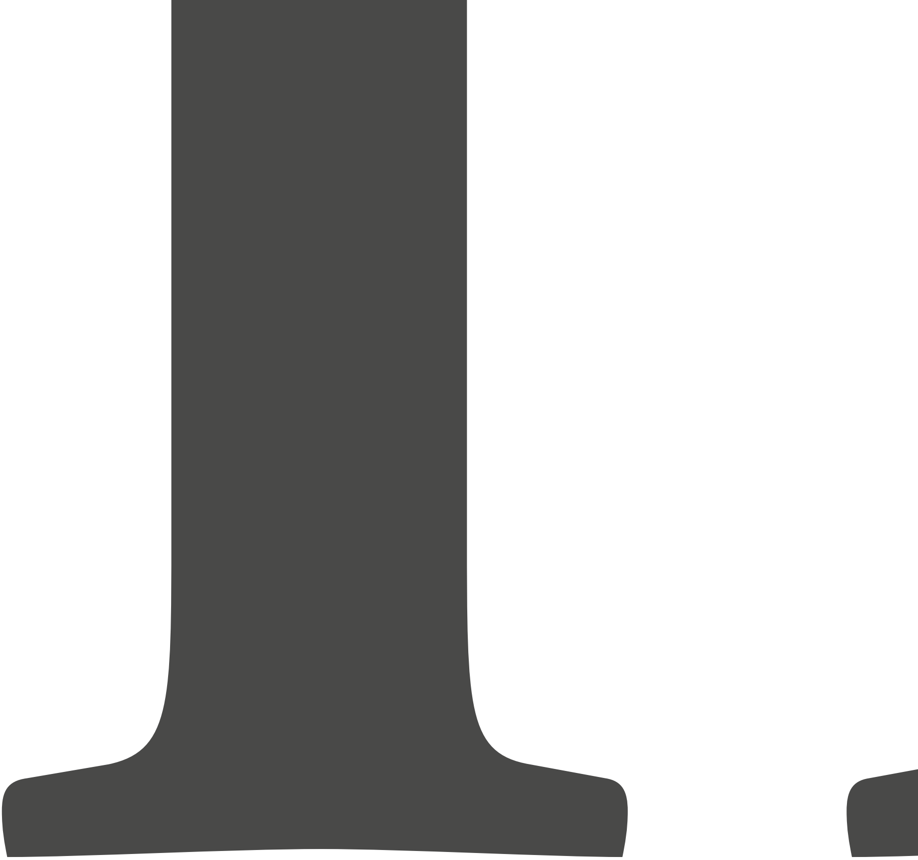
a

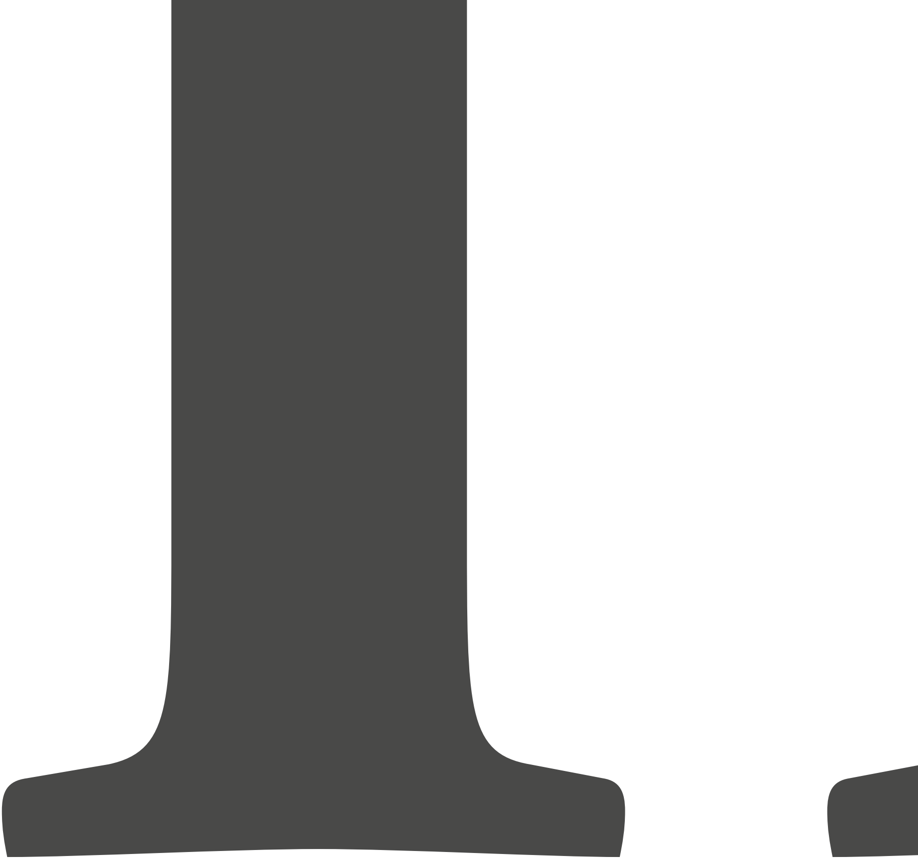


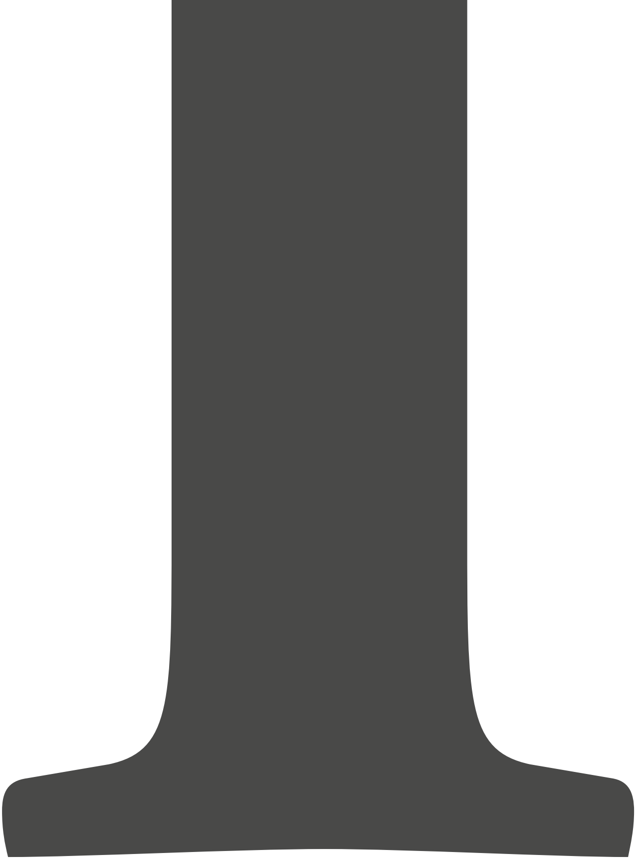


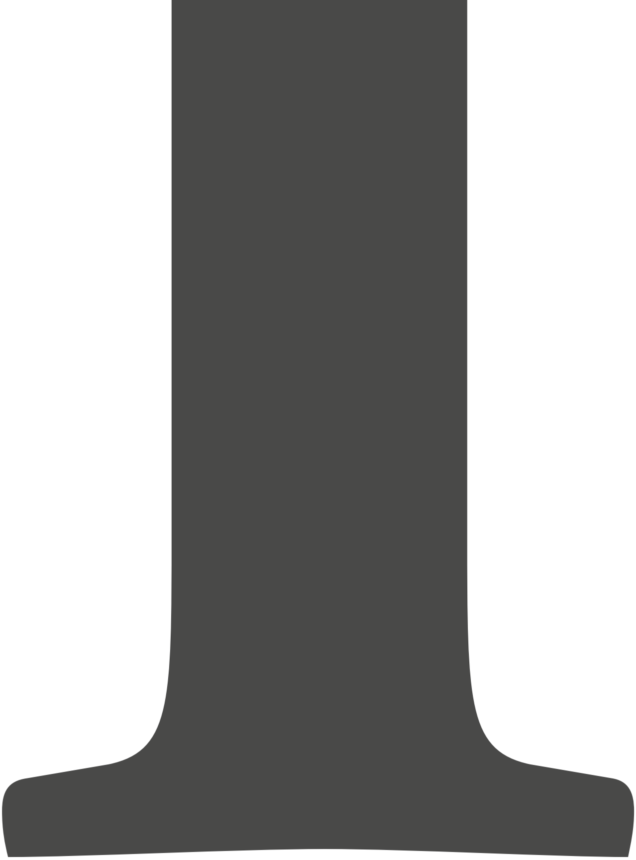




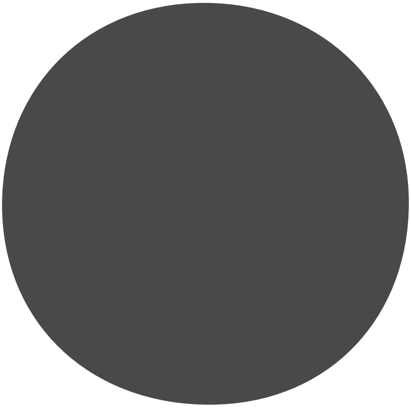






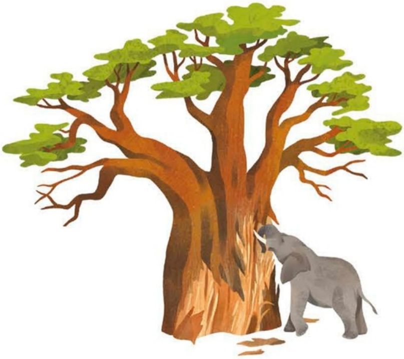


V



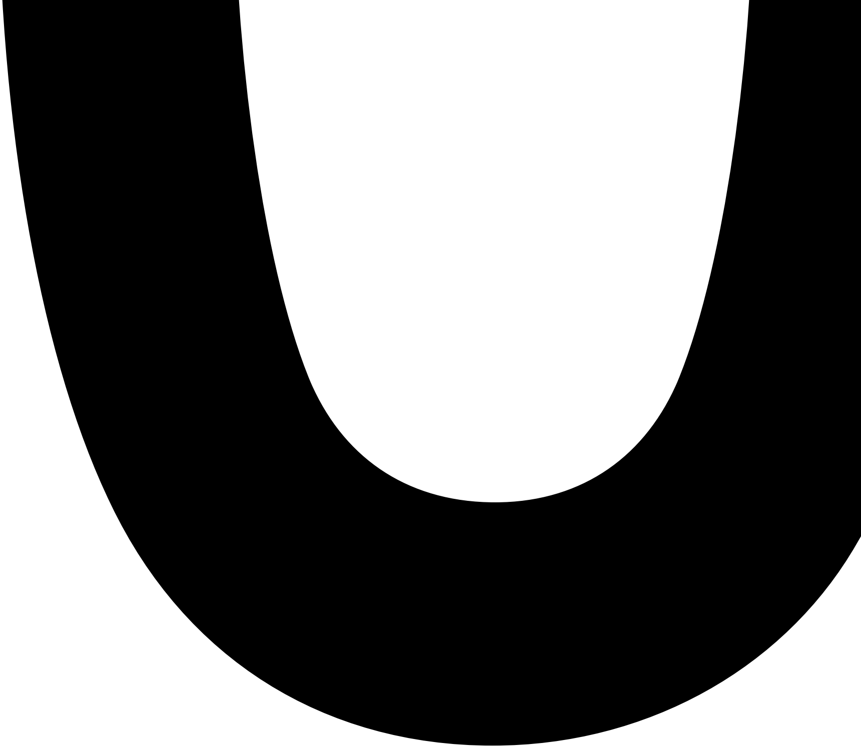
Baobab

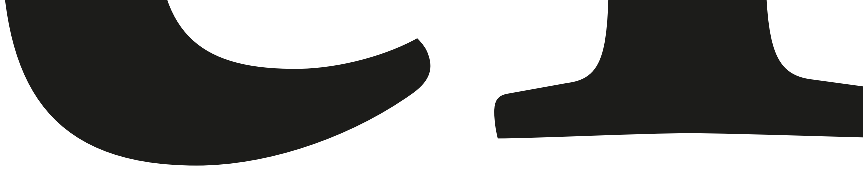
Afri
bao
(Adansoni
There are
of baobabs
baobab liv
Africa and v

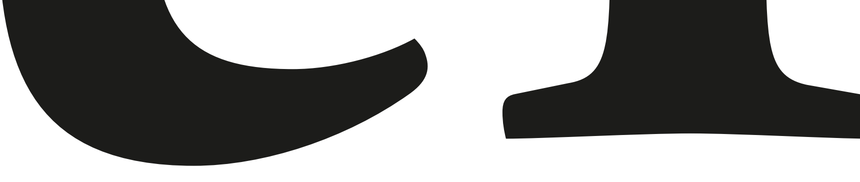


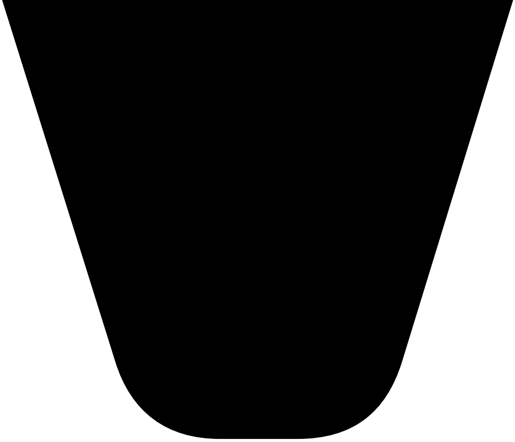
Water stealers

Thirsty elephants tear at the bark of baobabs to get at the damp inner wood. However, the trees heal themselves by creating new bark, which seals the wounds. Many baobab trunks bear the scars of past elephant attacks.









T

b

H

C

M

O

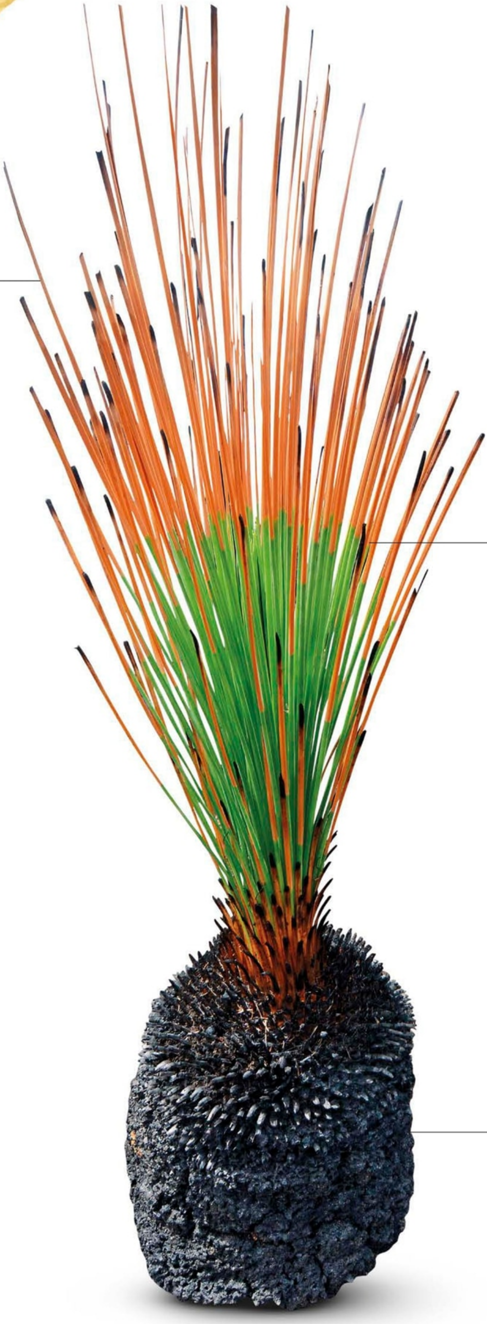
([illegible]

T

O-

b

A



T

g

it

p

T

C

st

n

p

E

tr

1 i

T

to

q

Y

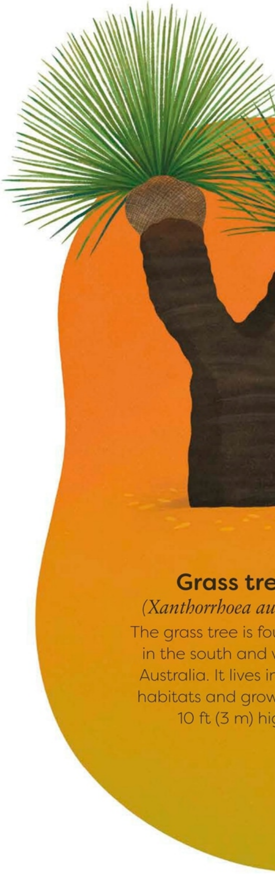
h

of

a

a

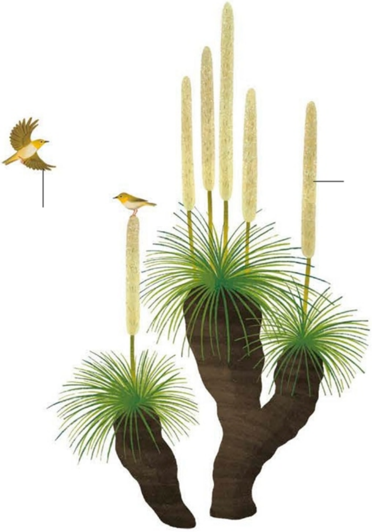
Grass tree



Grass tre

(Xanthorrhoea au

The grass tree is fou
in the south and w
Australia. It lives in
habitats and grow
10 ft (3 m) hig

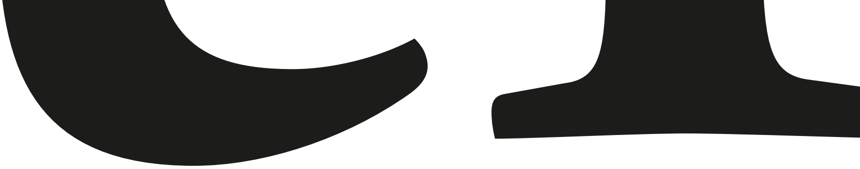


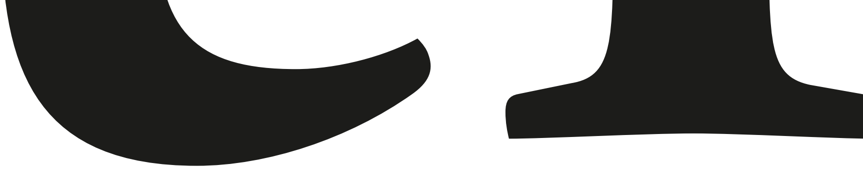
Fire flowers

As vegetation burns, it releases ethene gas. When the grass tree detects this, it sends up a giant flower spike, which contains thousands of tiny blooms. Small birds called silvereyes visit to sip the nectar, and at the same time spread the pollen between different grass trees.

[redacted]

L





A

g

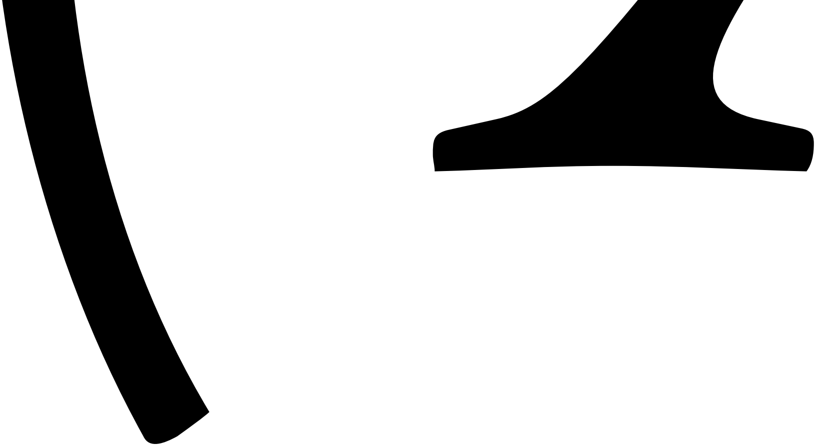
it

C

b

n

th



T

in

A

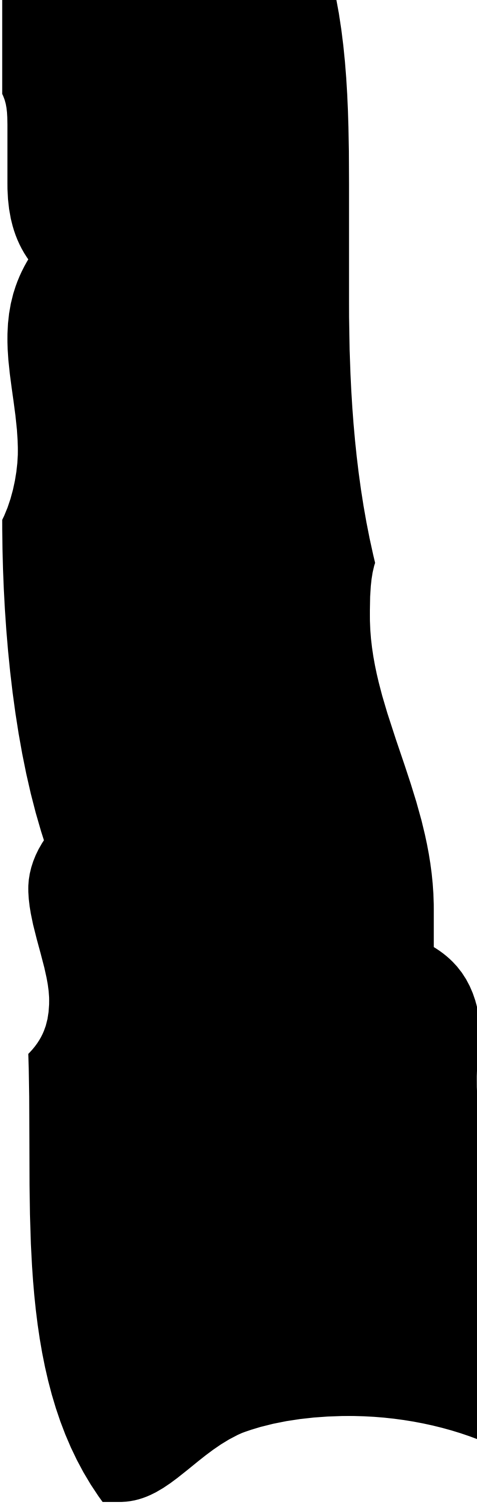
h

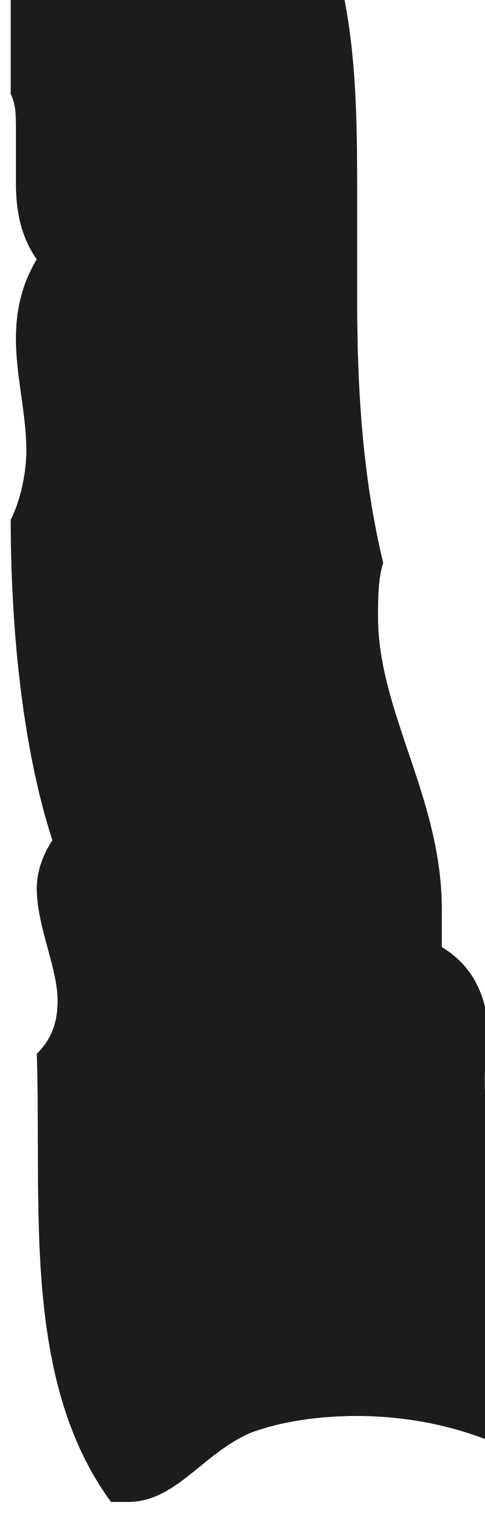
1

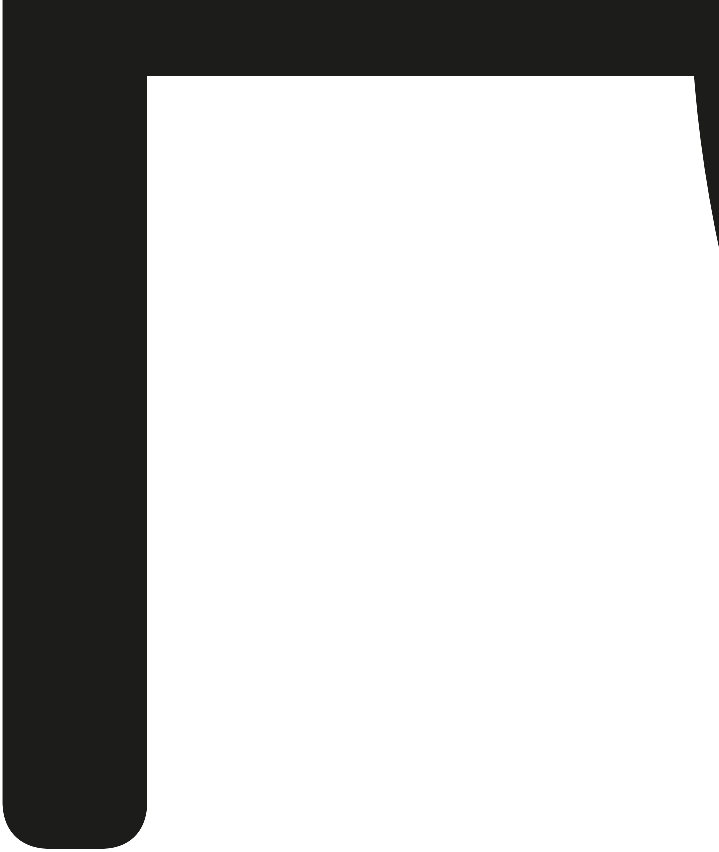
S

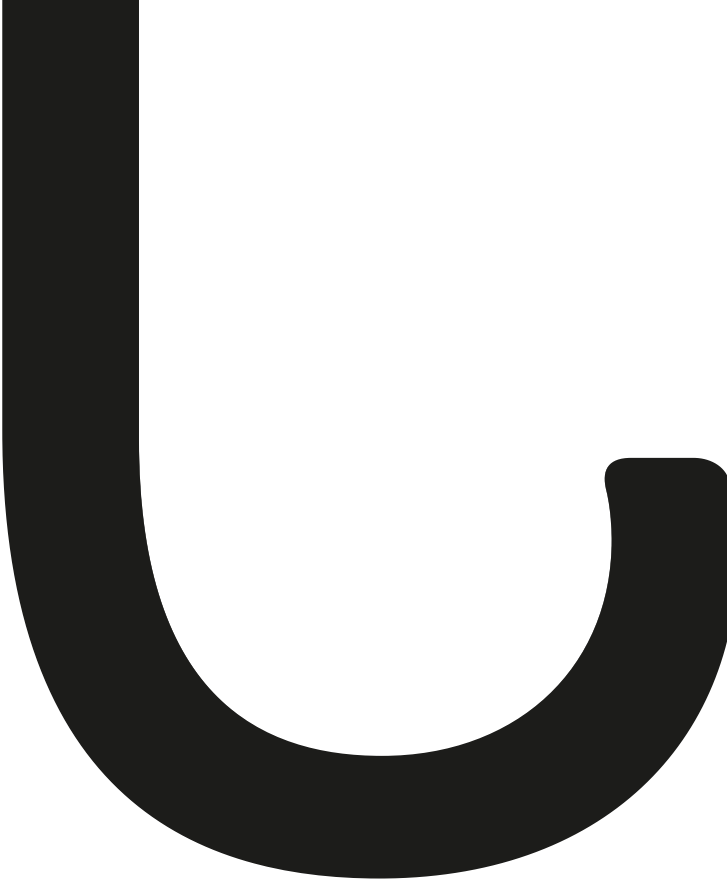
F

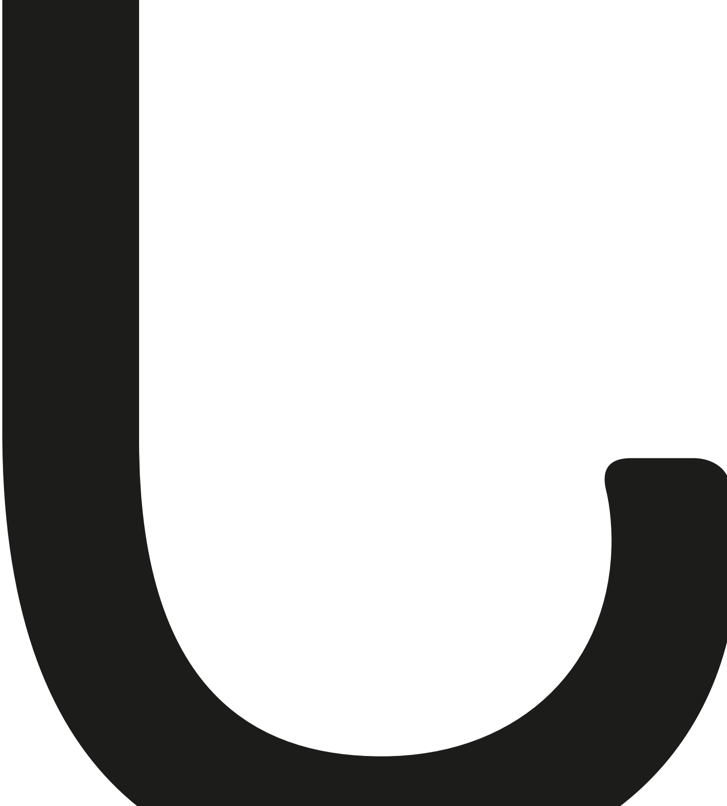
Roots and bulbs

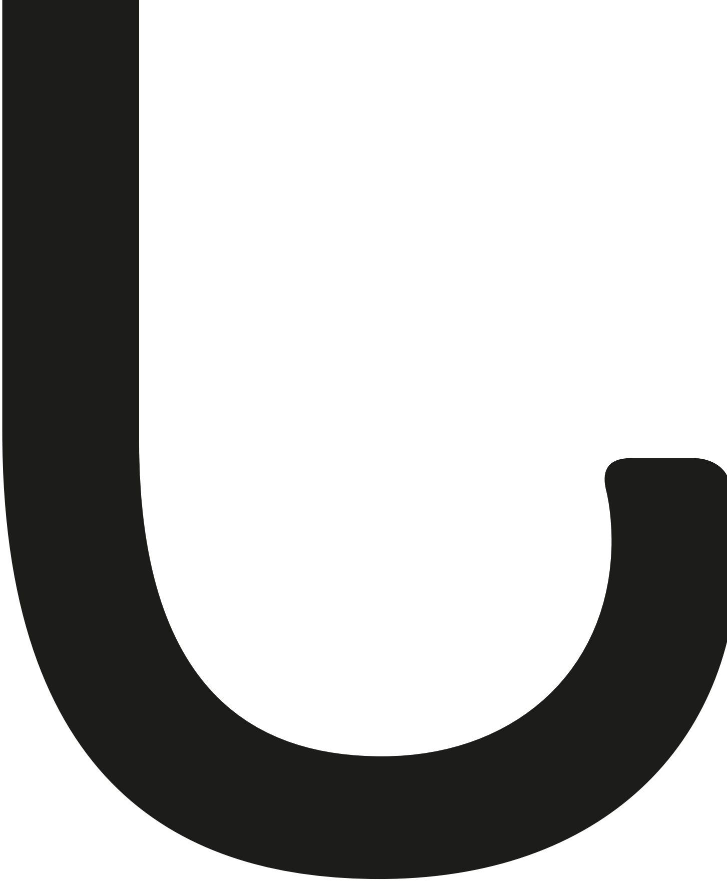




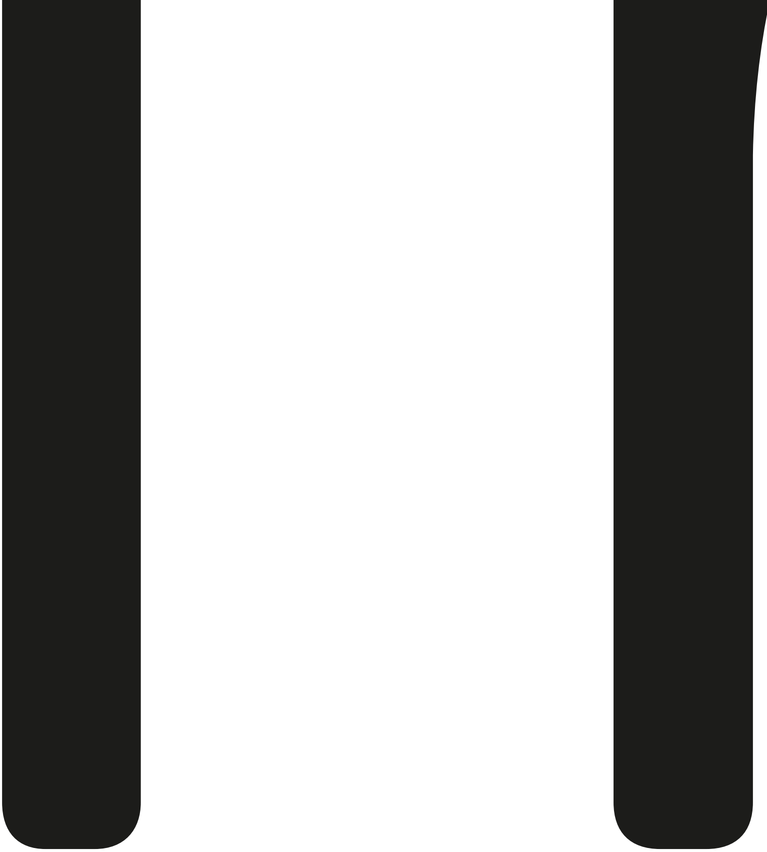








K



A

a

O

p

o

T

g

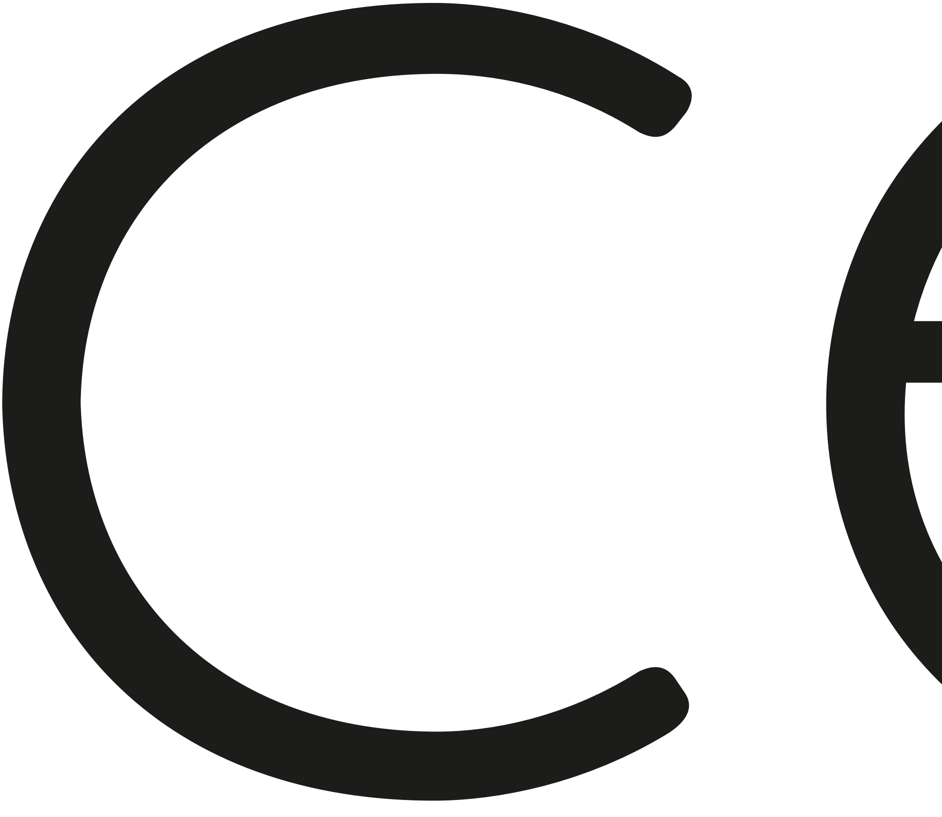
g

T

C

fu

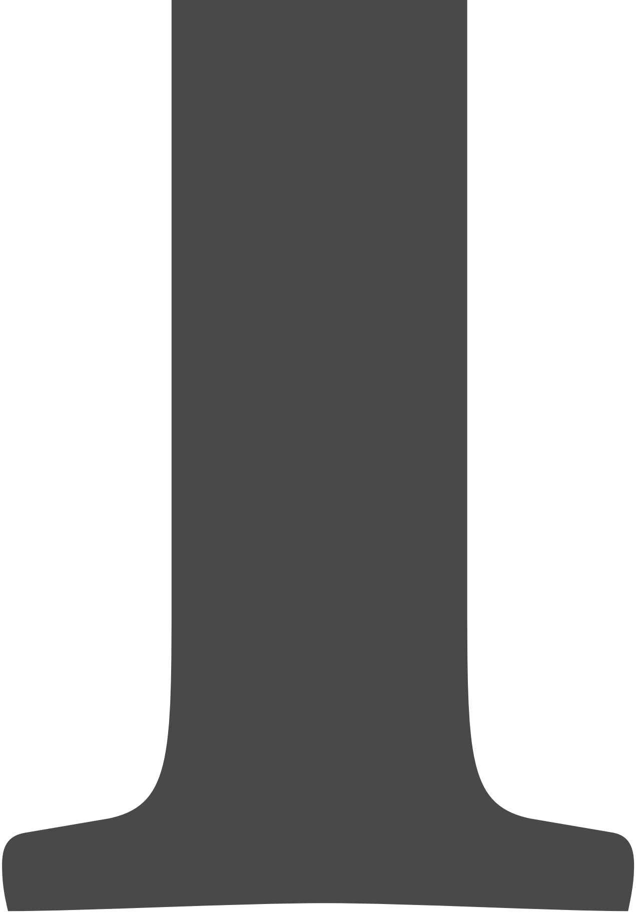
C

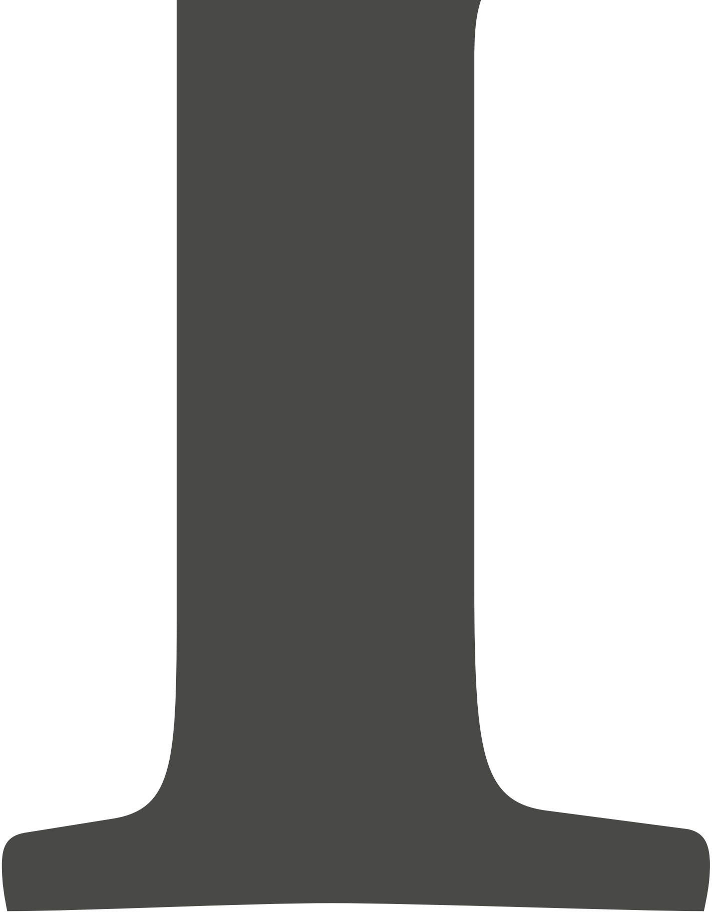


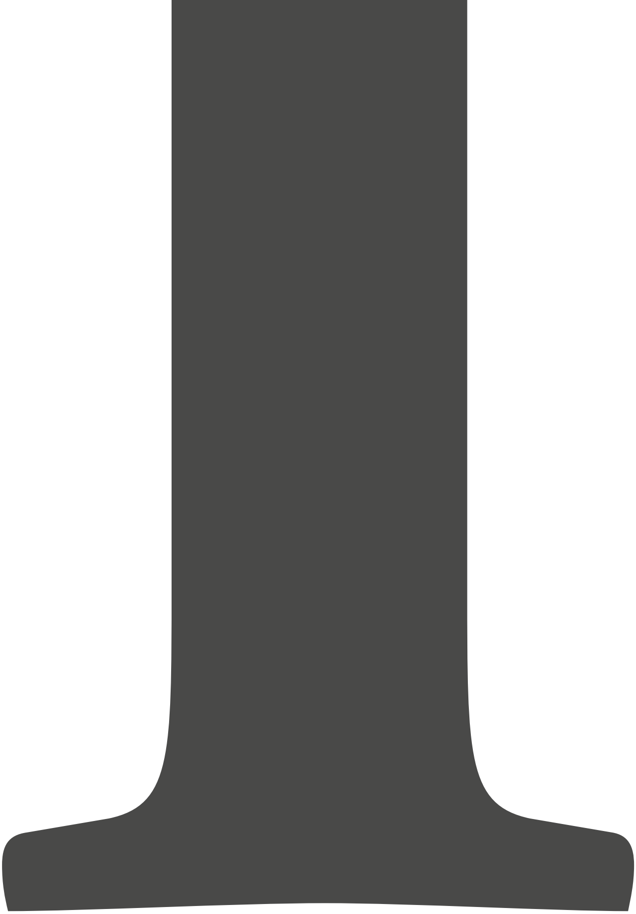
W

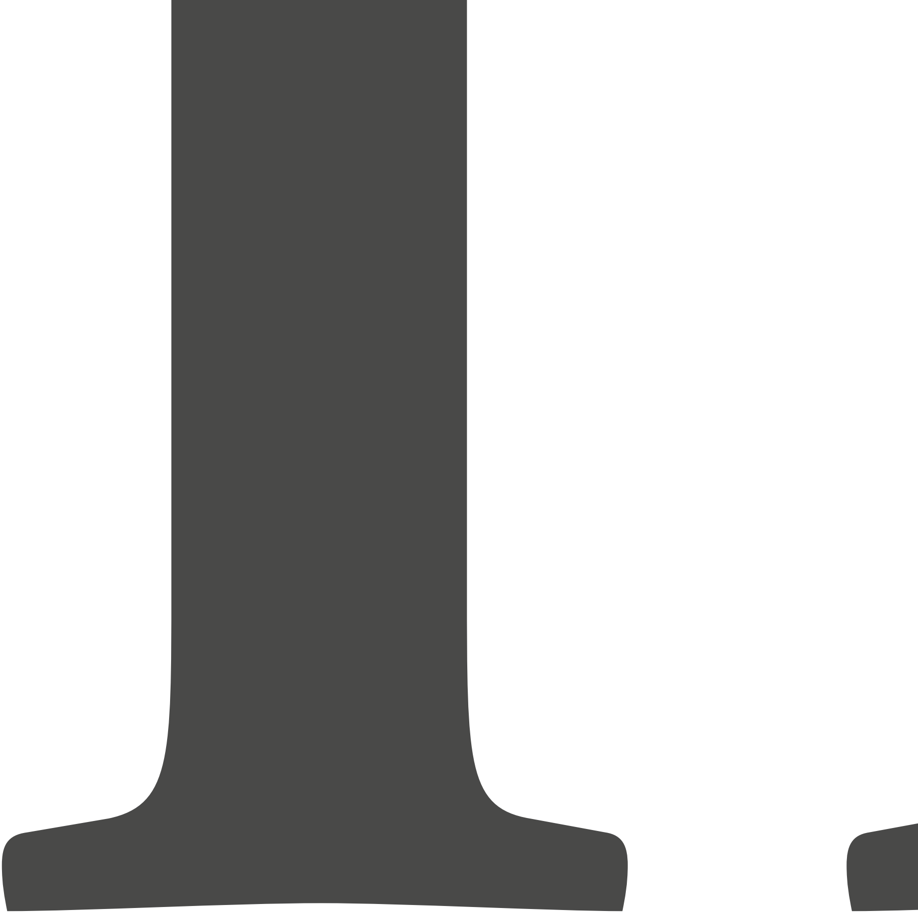
re

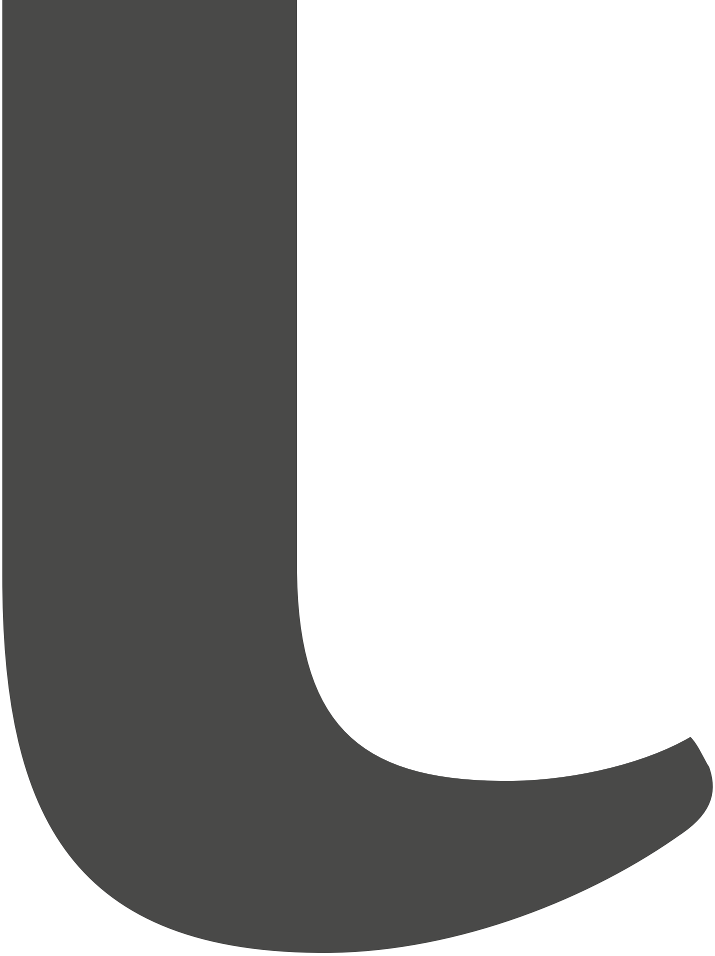
le

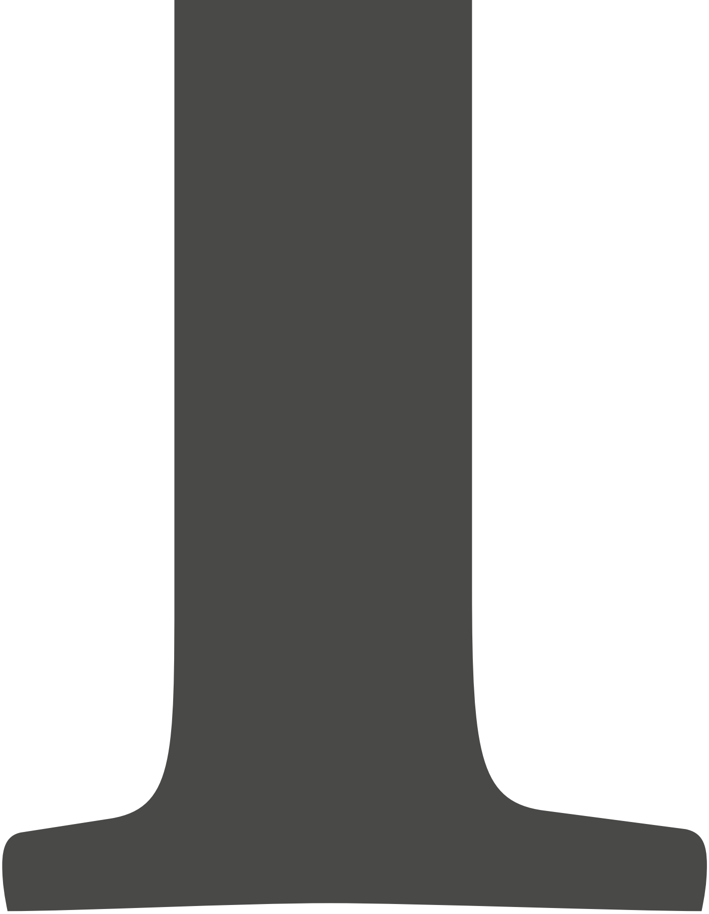


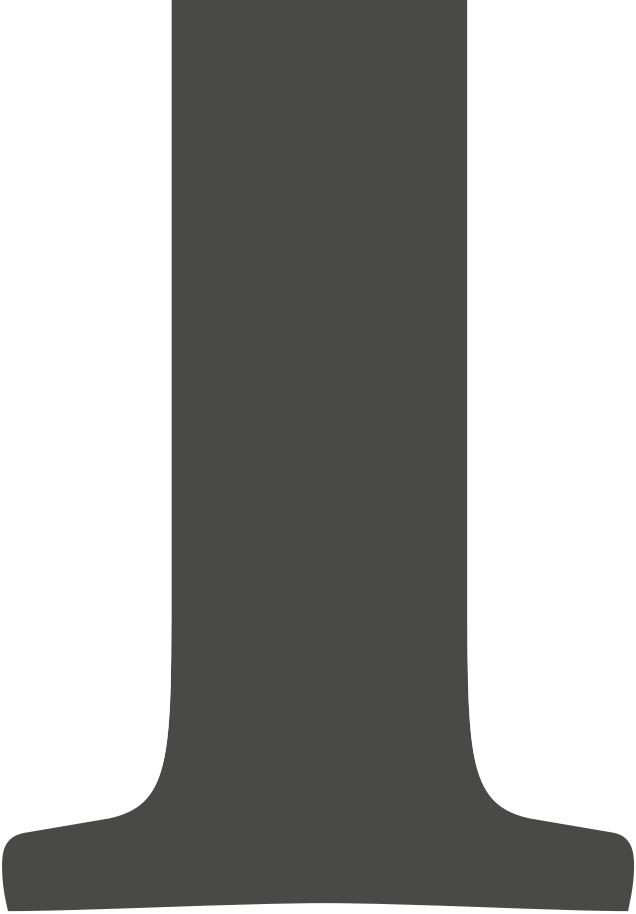




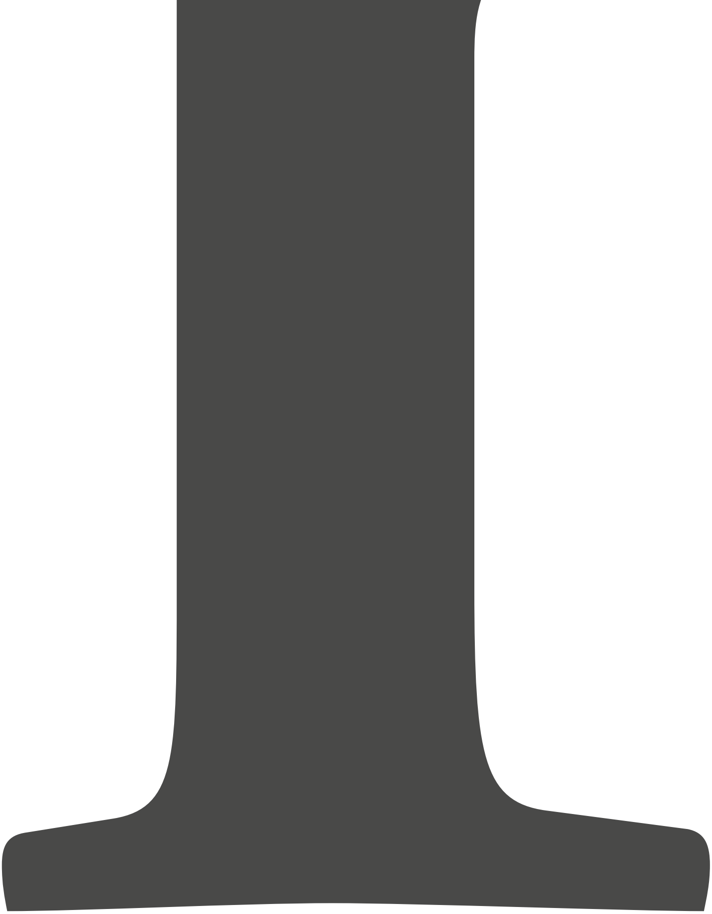


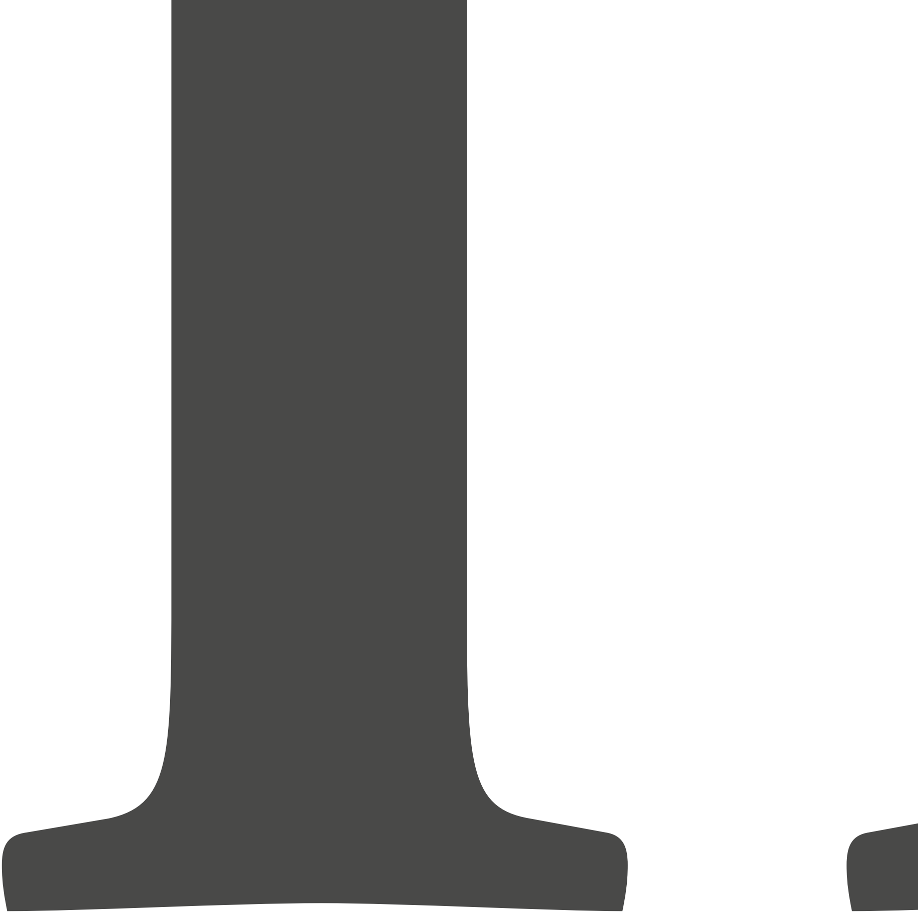




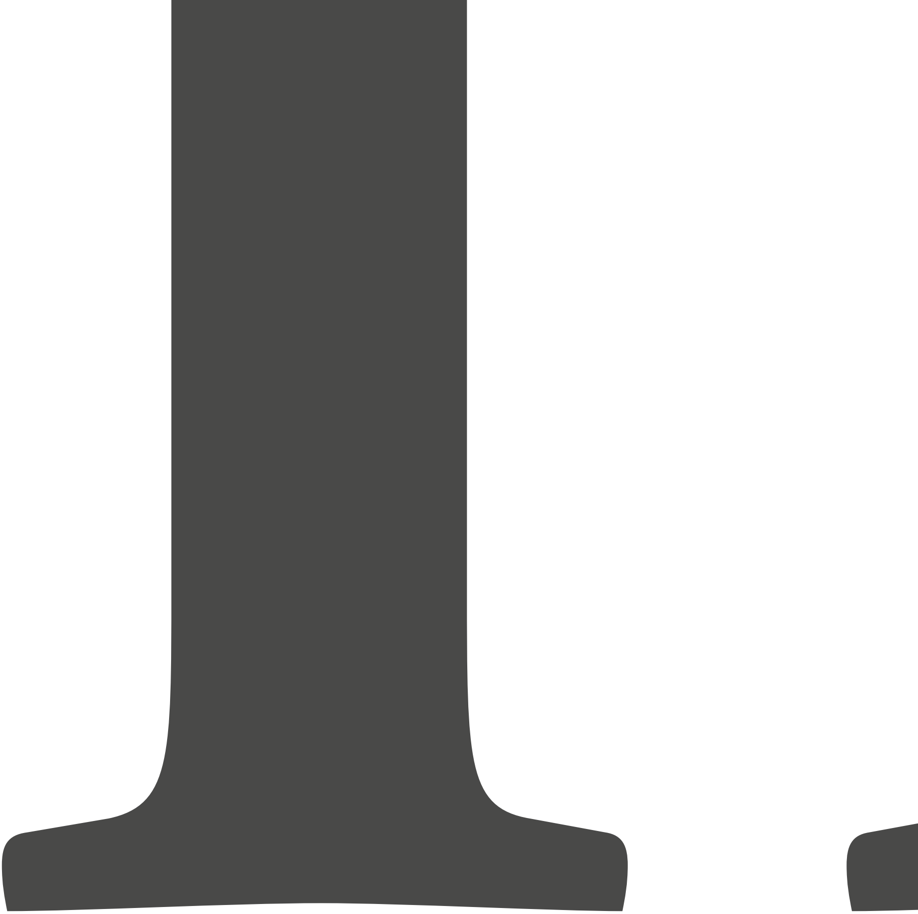


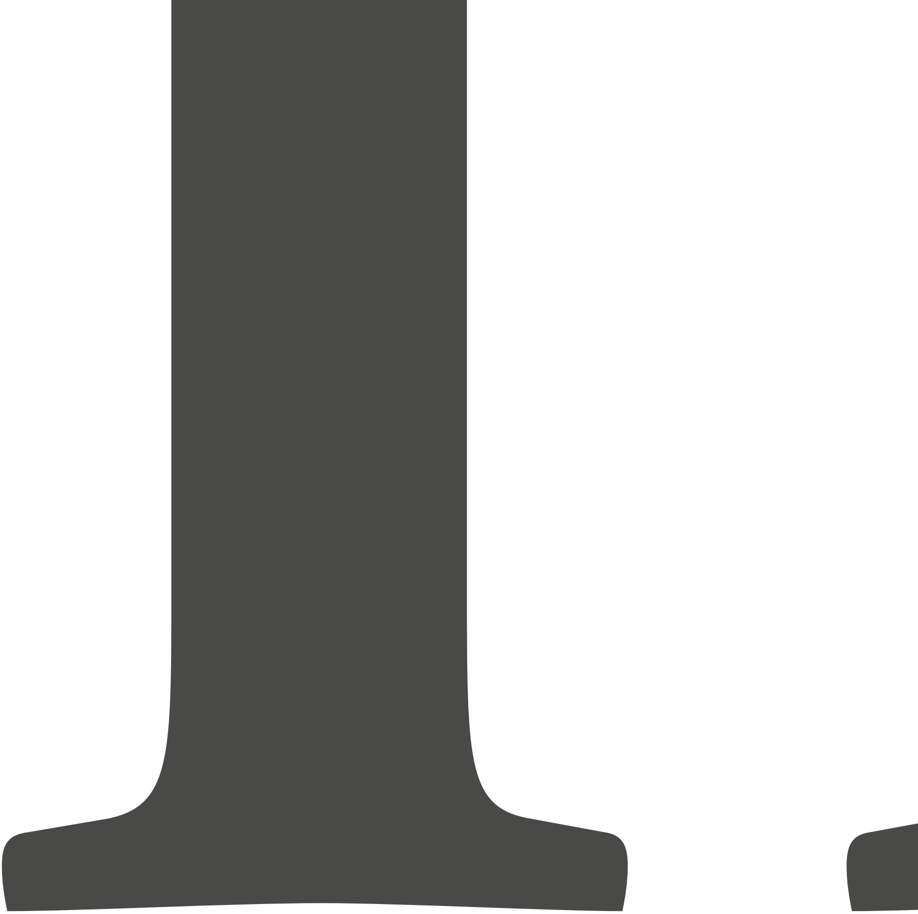
V

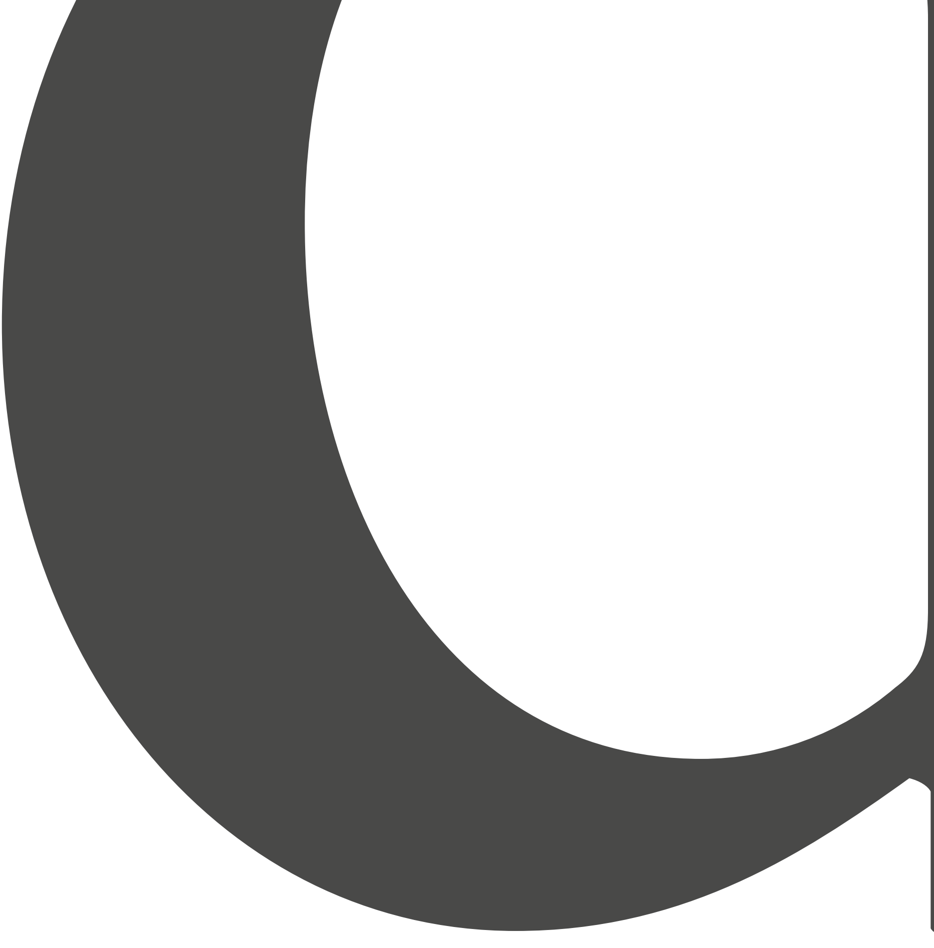


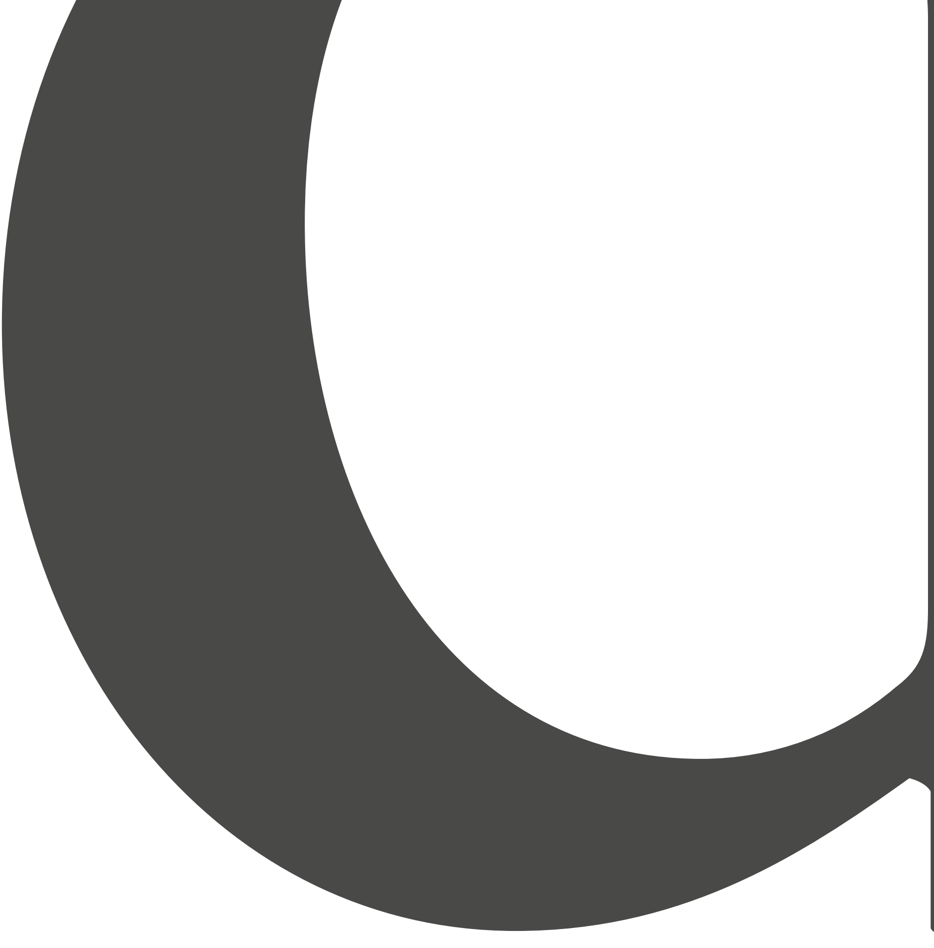


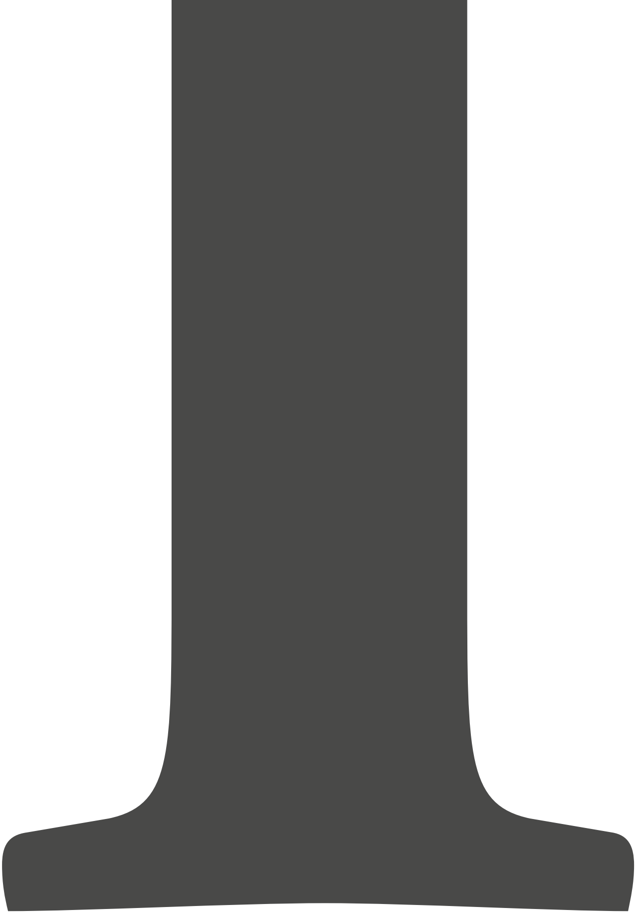
y

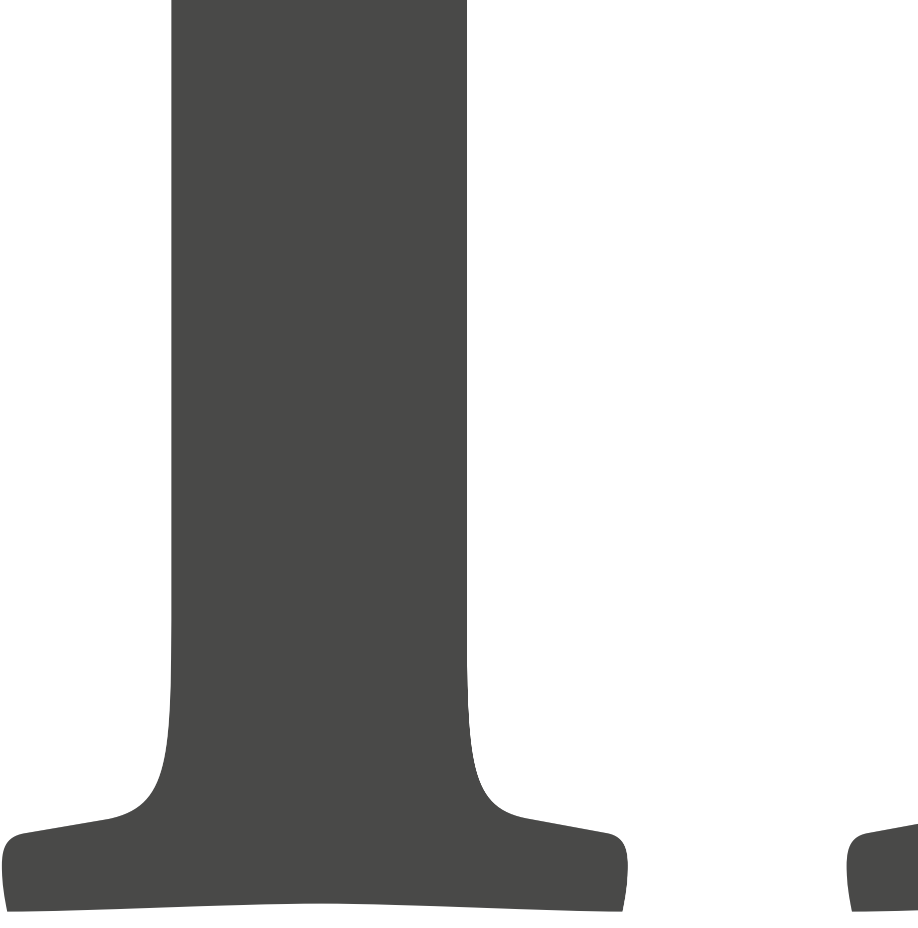


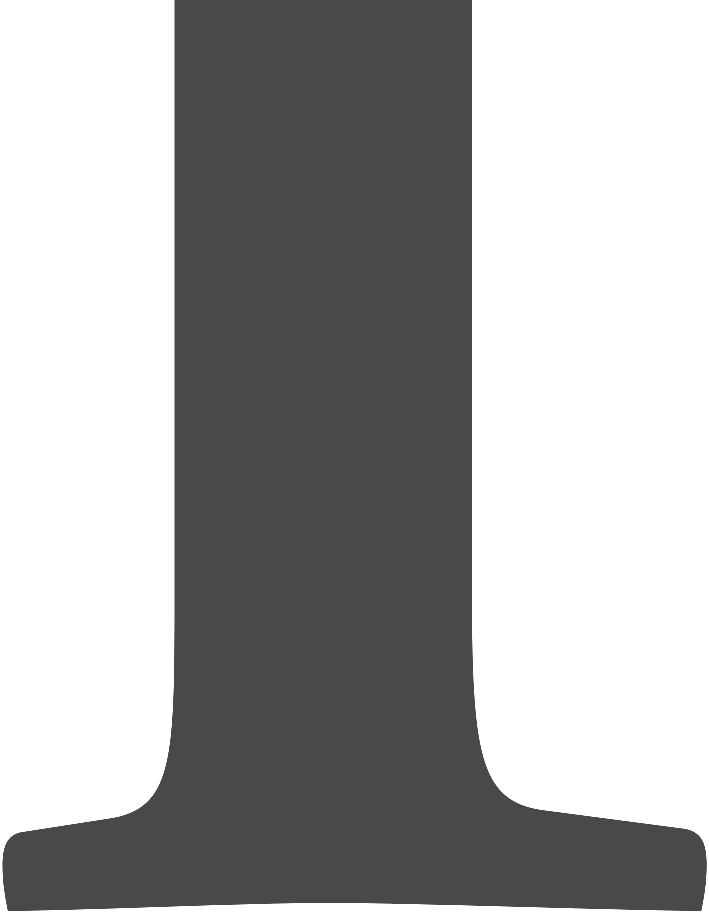


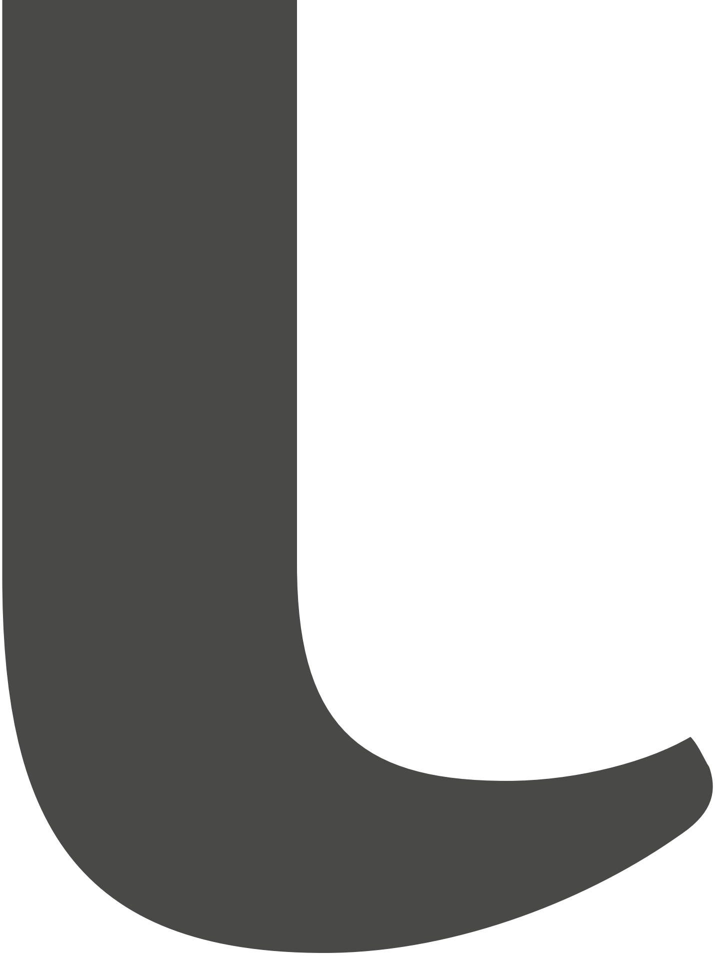


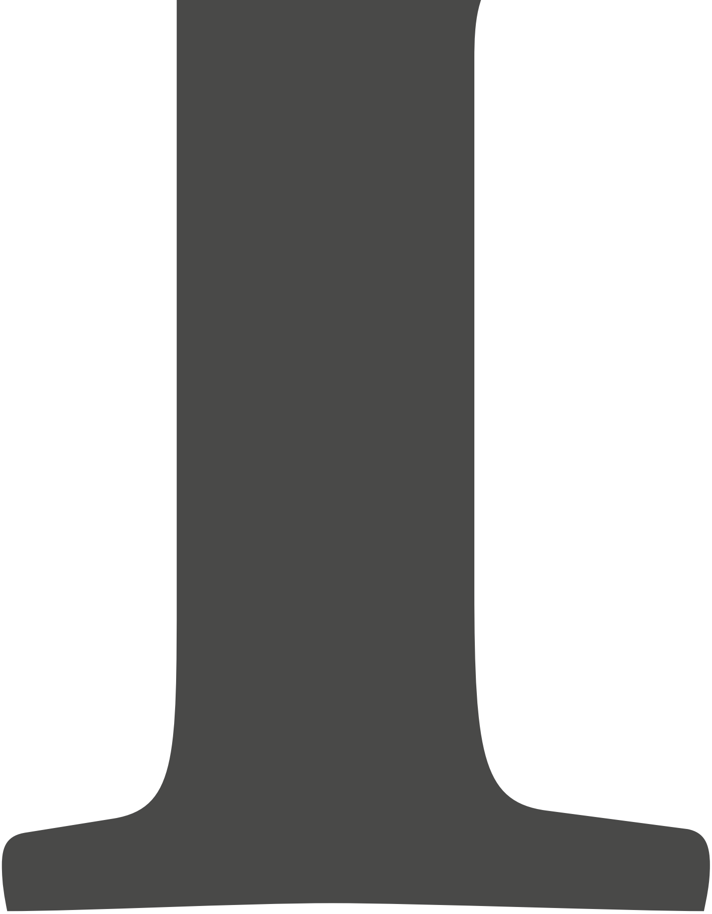


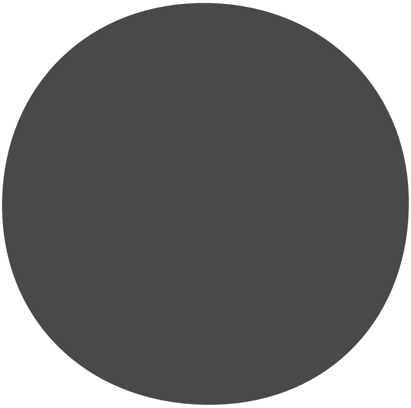




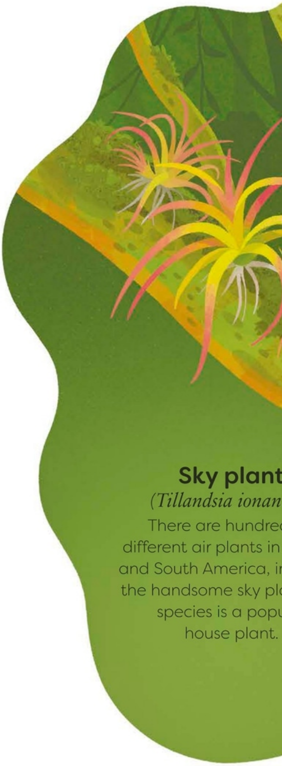




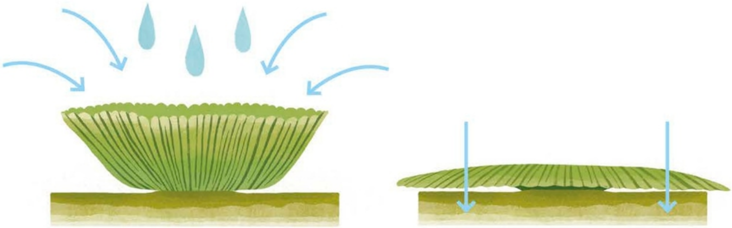




Air plant



Sky plant
(Tillandsia ionan
There are hundre
different air plants in
and South America, i
the handsome sky pl
species is a popu
house plant.



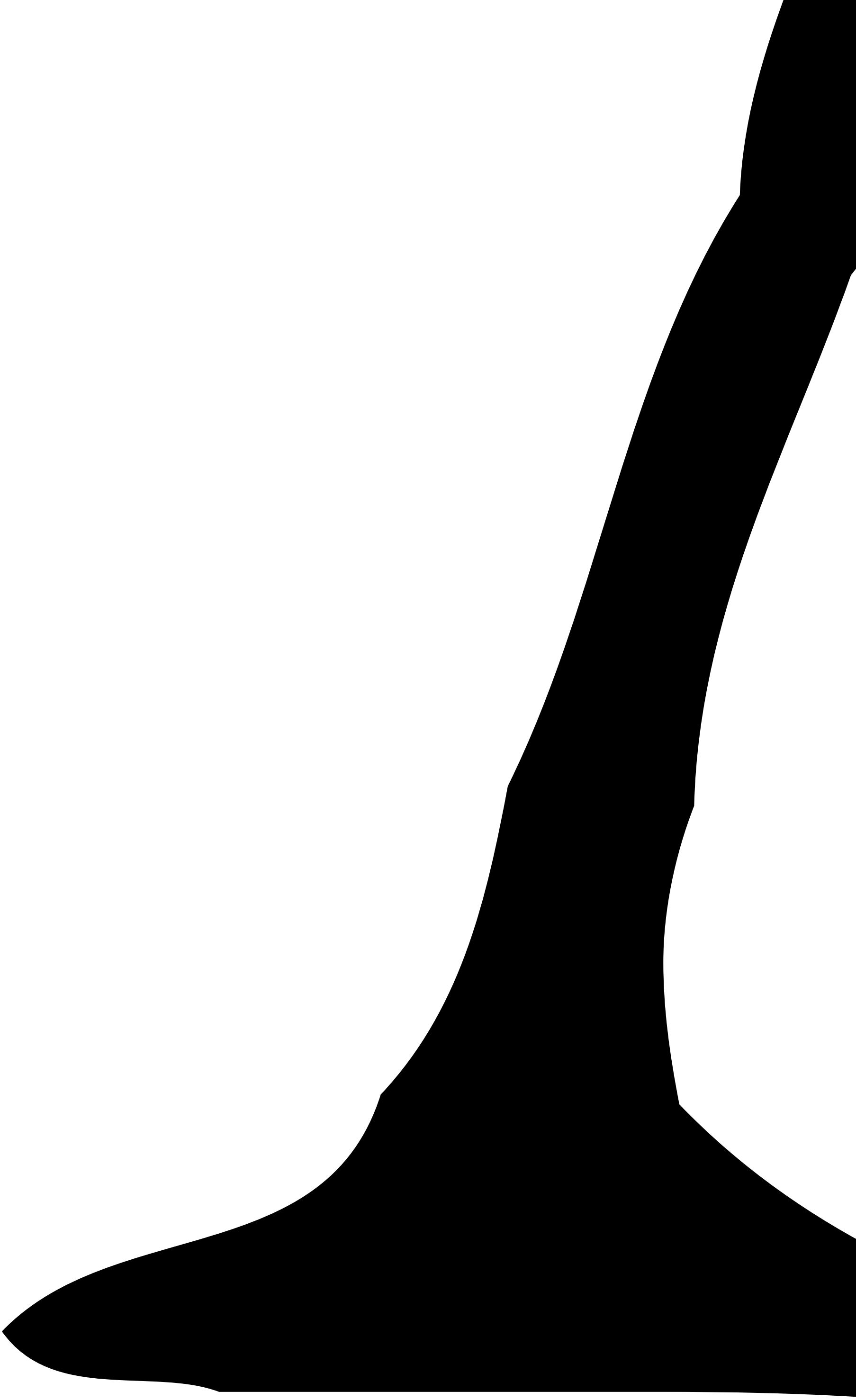
Absorbing water

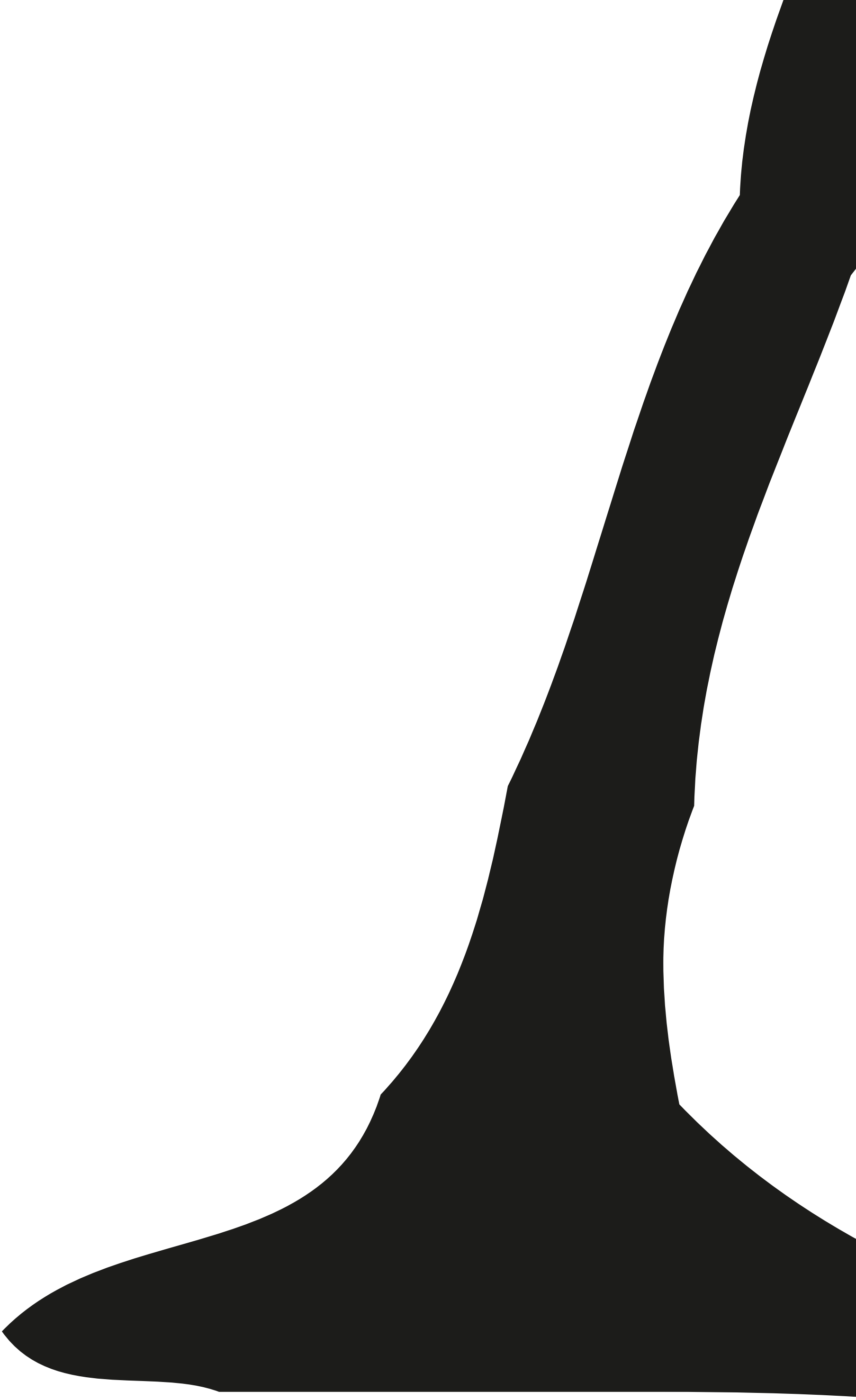
The surface of every air plant leaf has many tiny structures, called trichomes. When droplets of water fall on a trichome, it soaks them up like a miniature sponge. The trichome fills with water, then empties its contents into the leaf below.

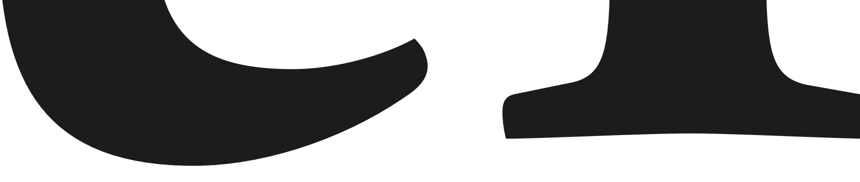
[redacted]

[redacted]

[redacted]







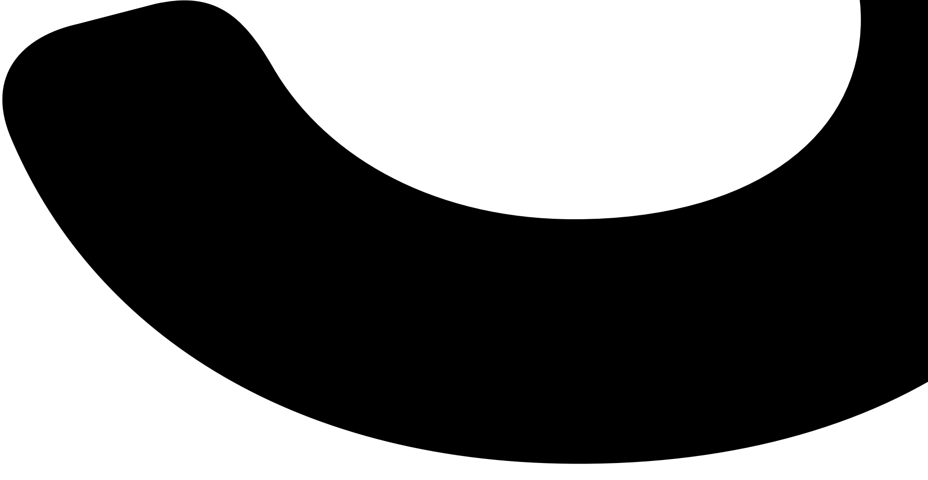
T

st

W

m

th



(

T

d

a

th

sp

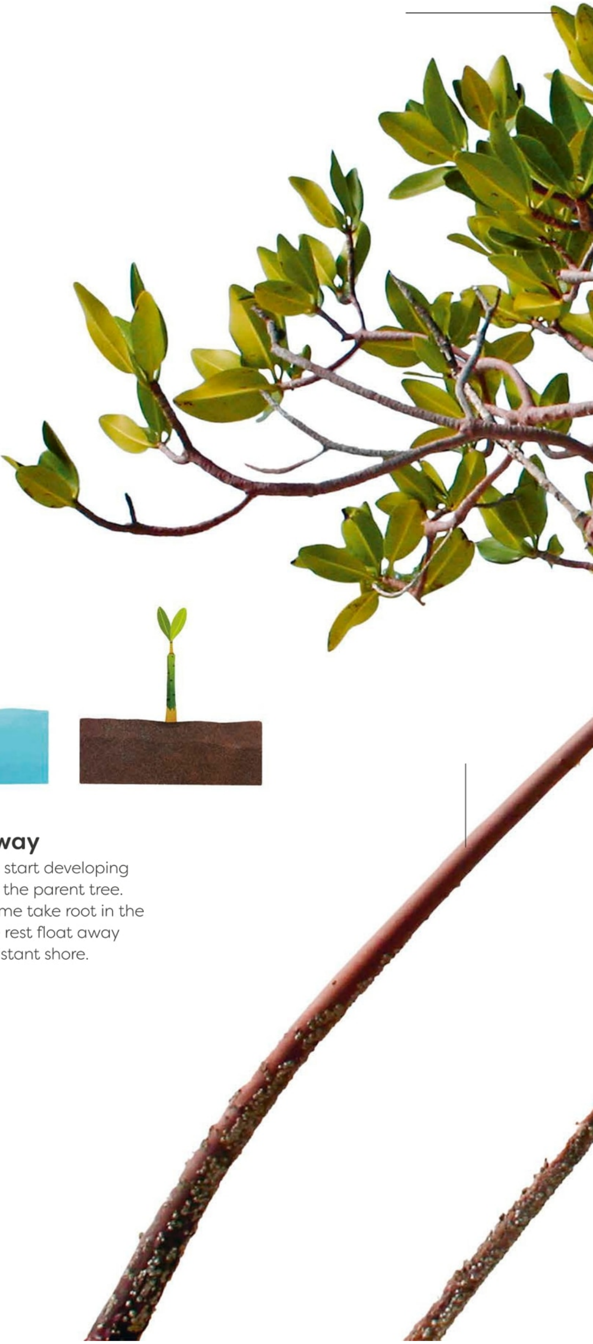
h

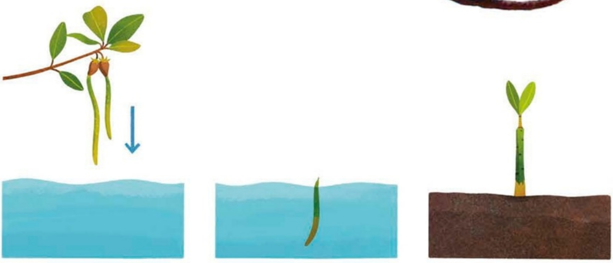
S

w

R

w





Floating away

Mangrove seeds sprout and start developing roots while still attached to the parent tree. When the seedlings fall off, some take root in the mud near the tree, but the rest float away until they settle on a distant shore.

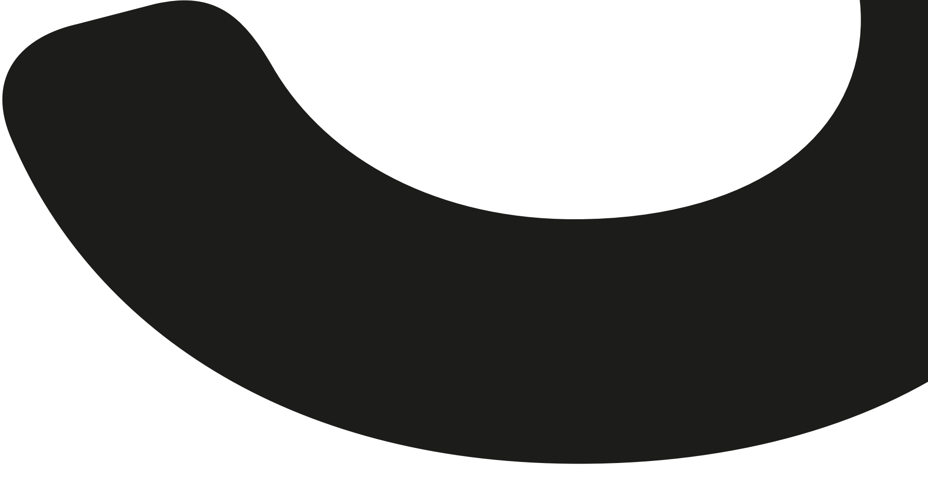
M

r

W

m

u



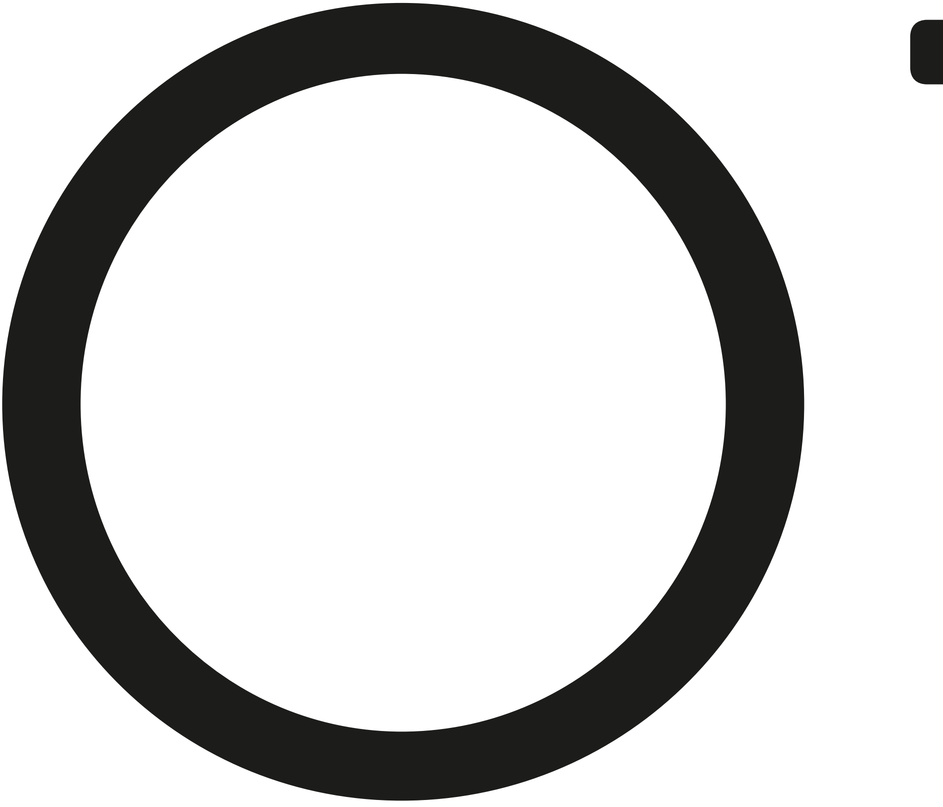
S

d

th

fr

se



A

m

t

p

h

fr

T

ro

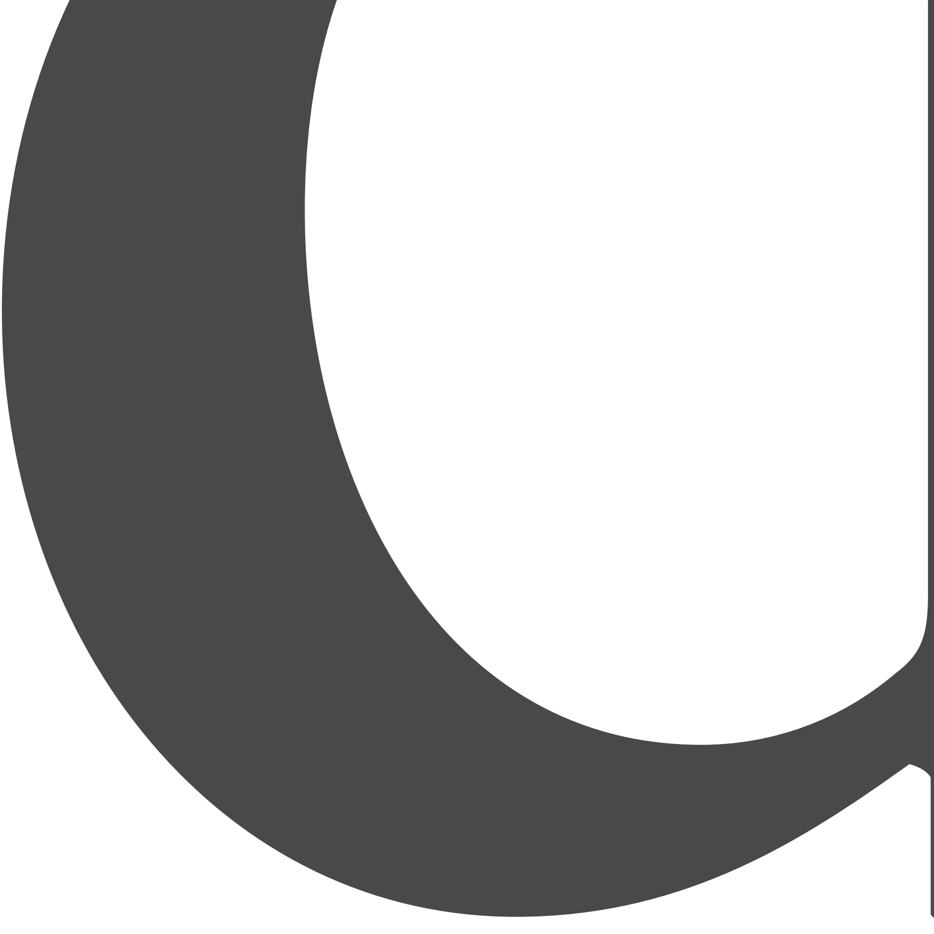
se

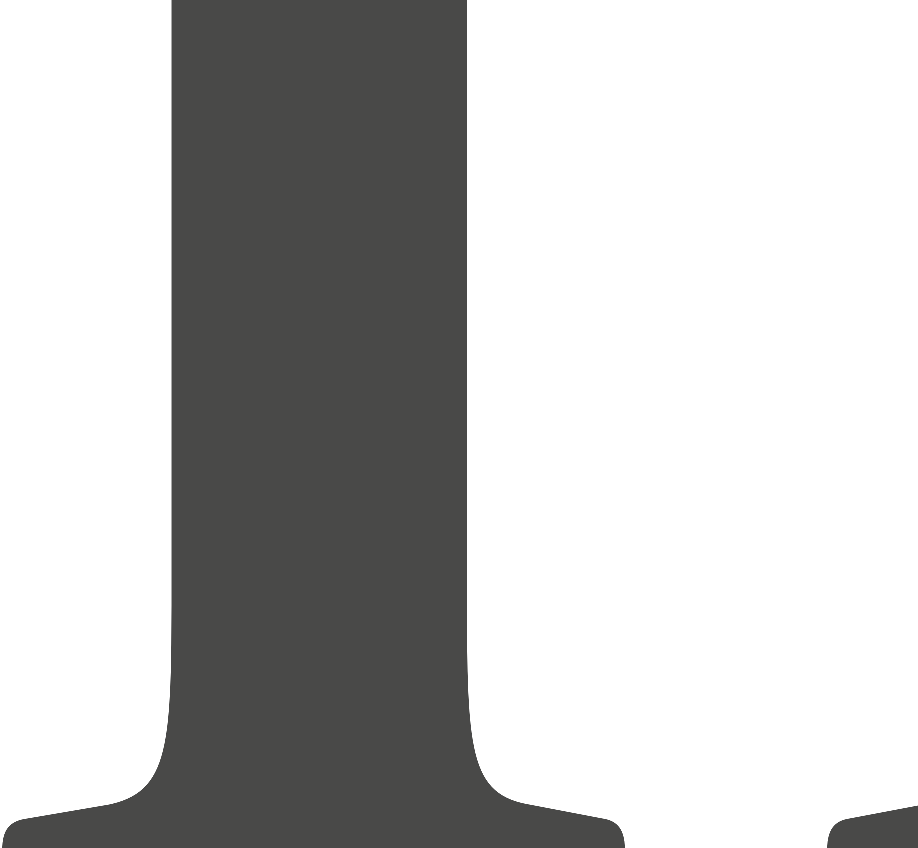
T

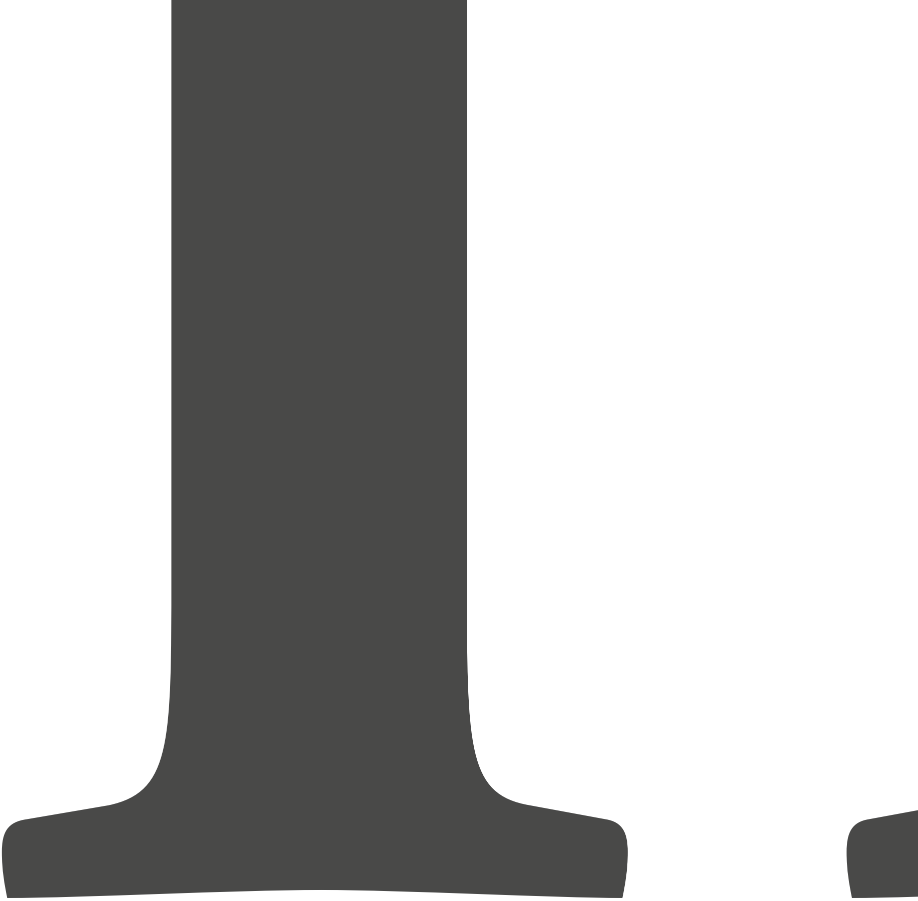
of

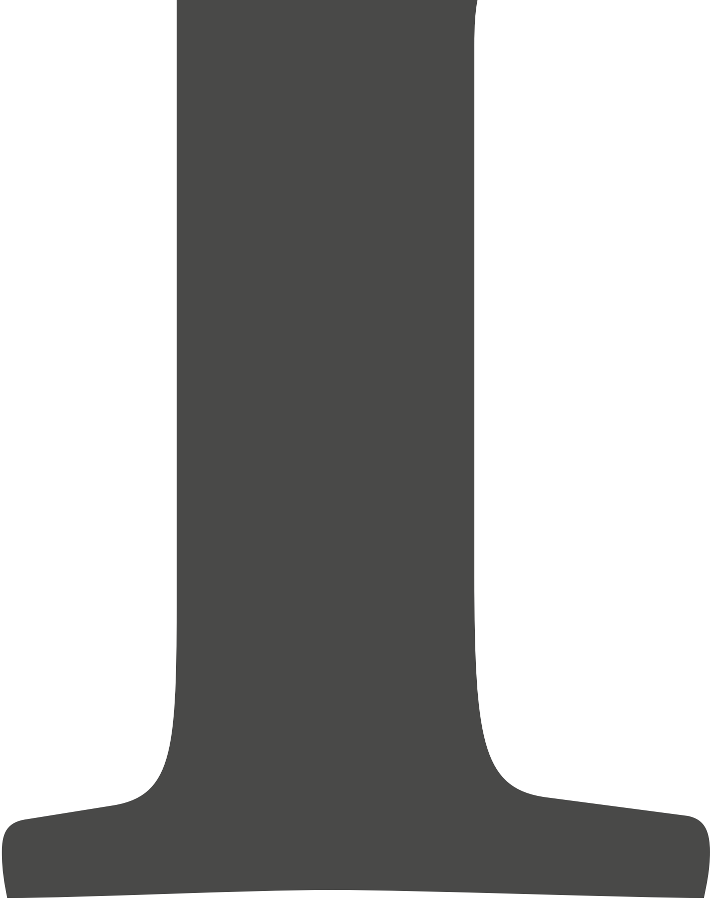
he

S

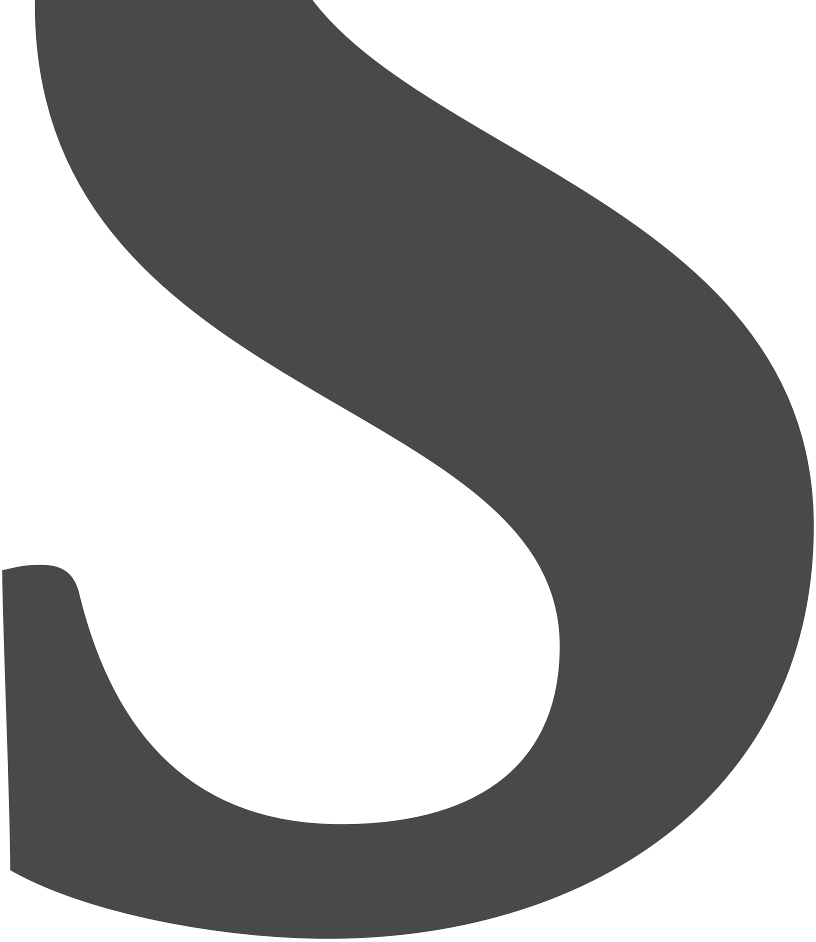


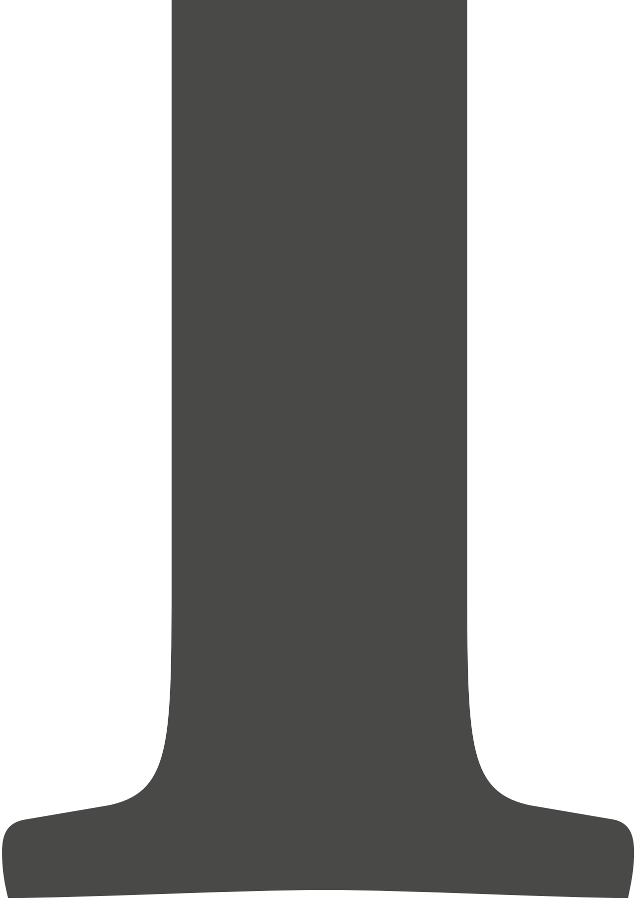




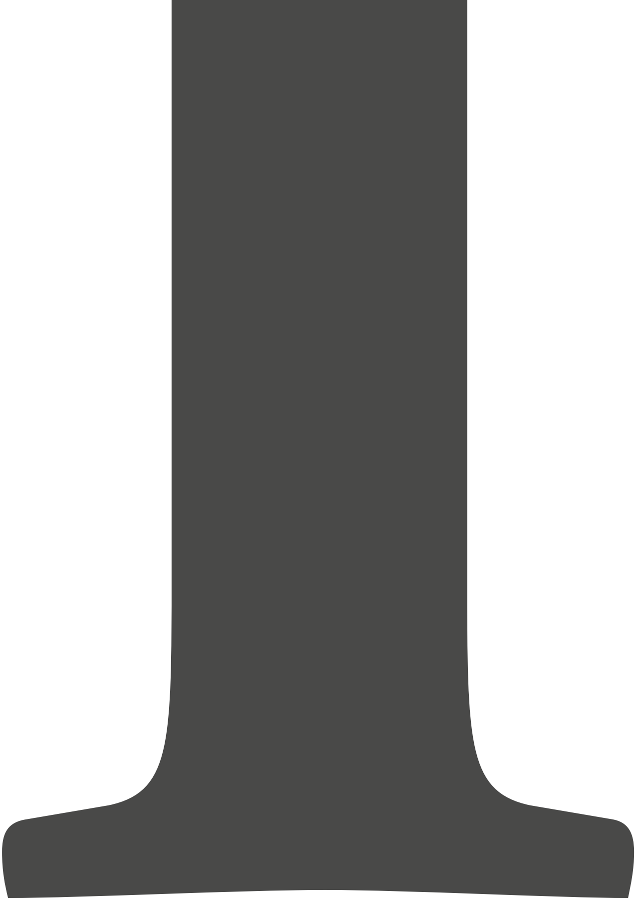


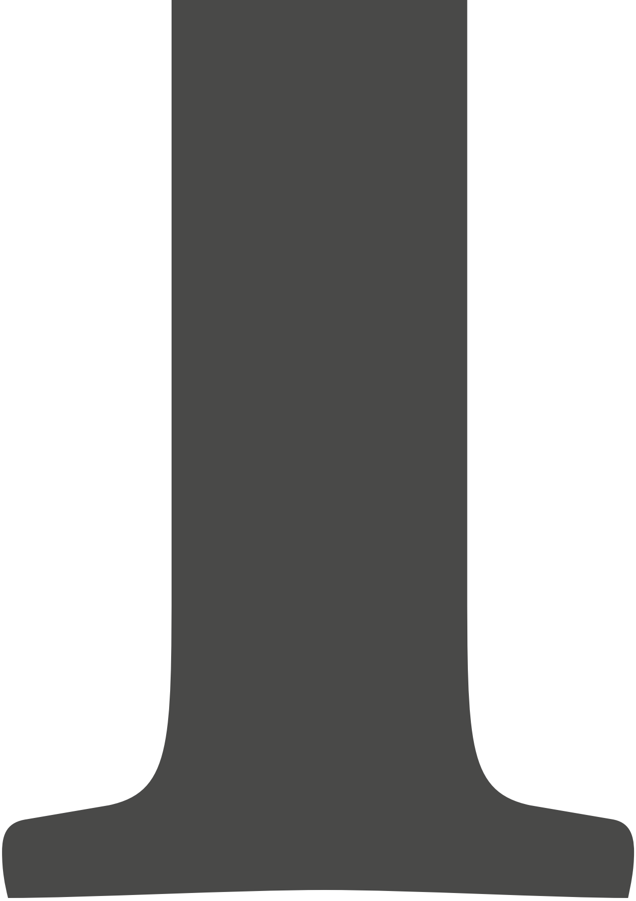
V



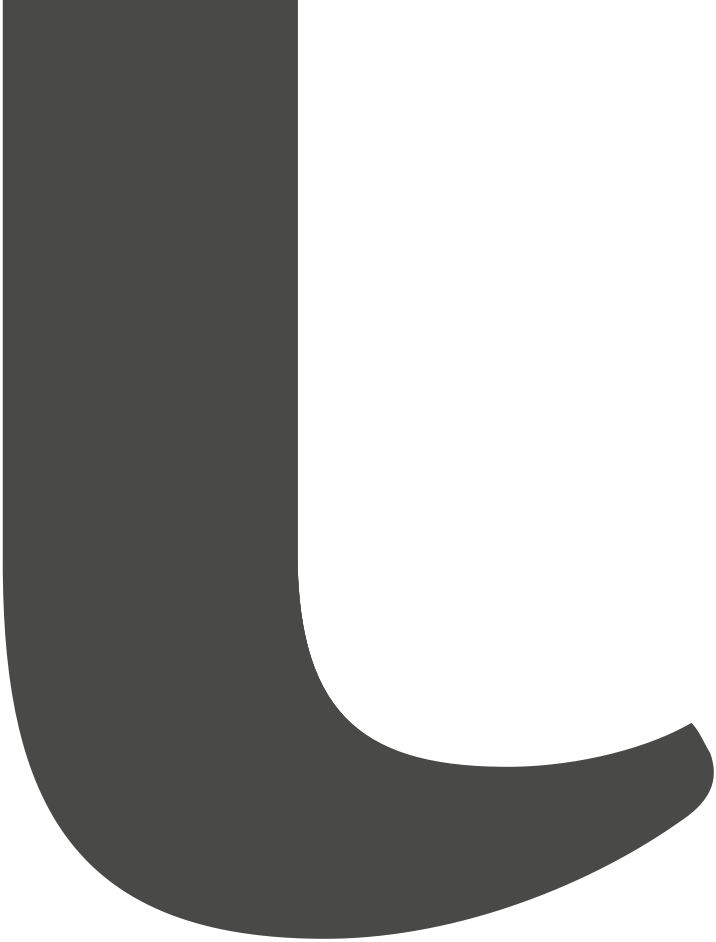


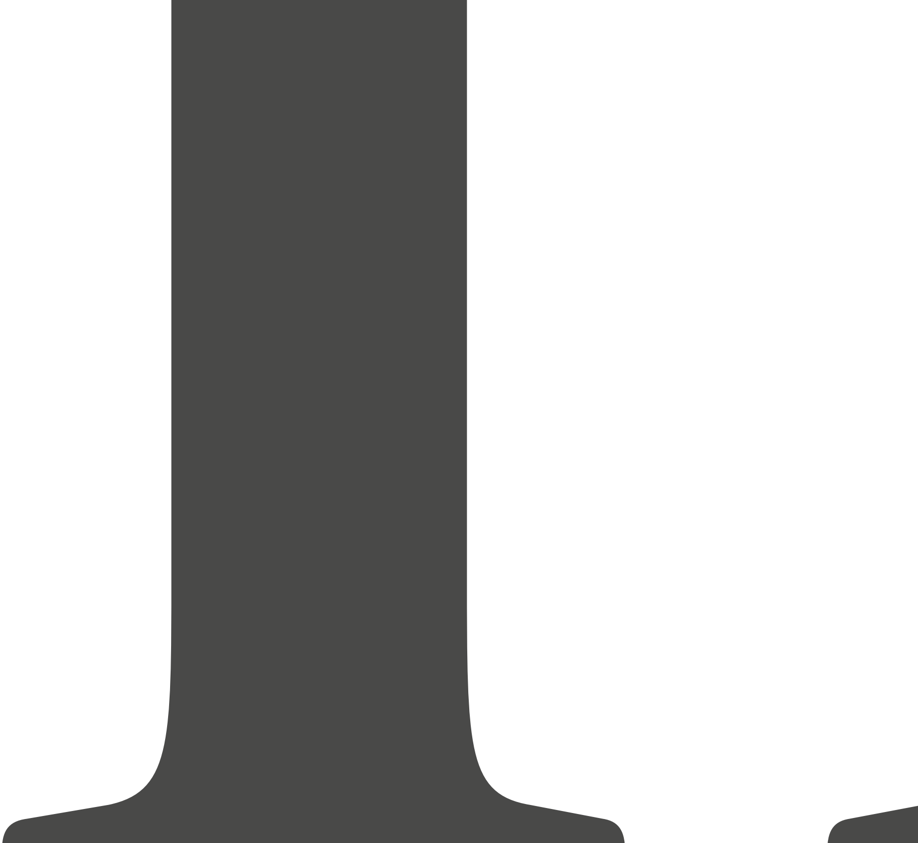
K



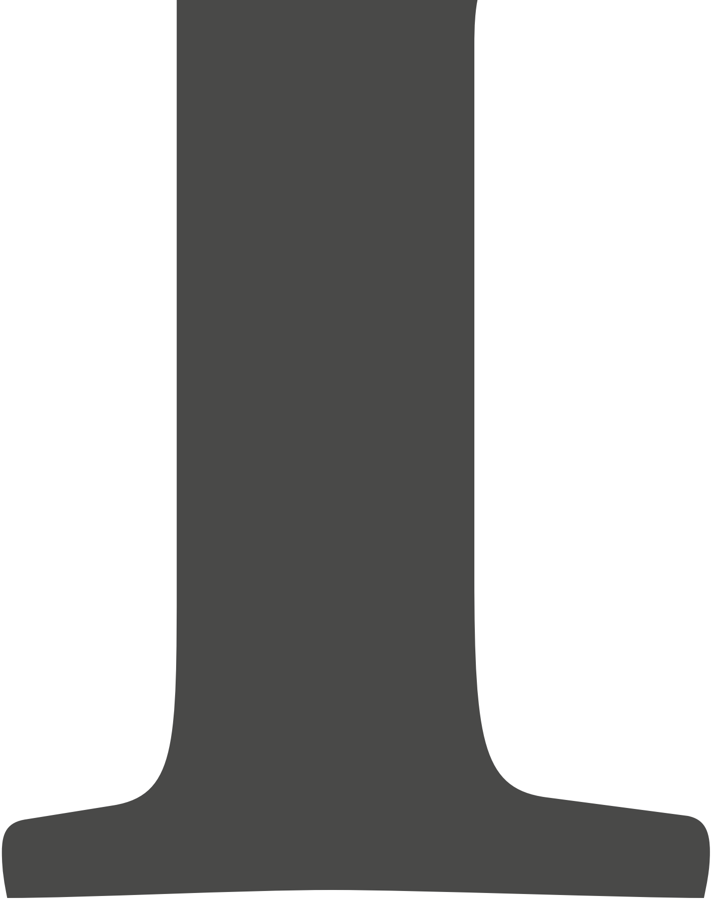


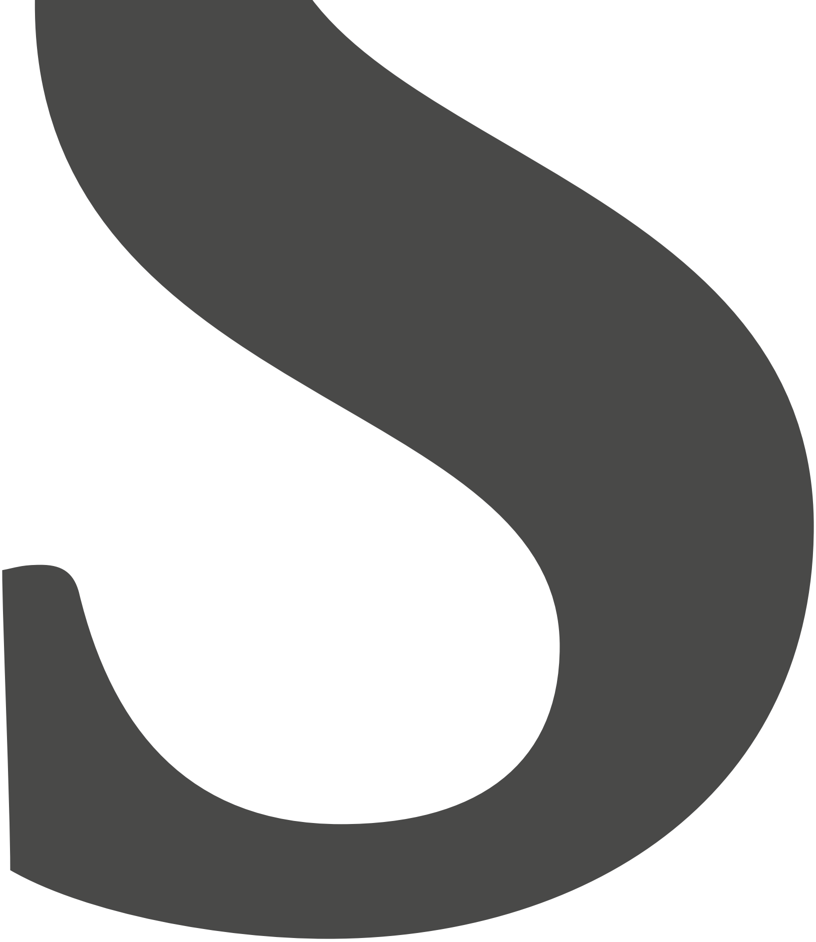
K

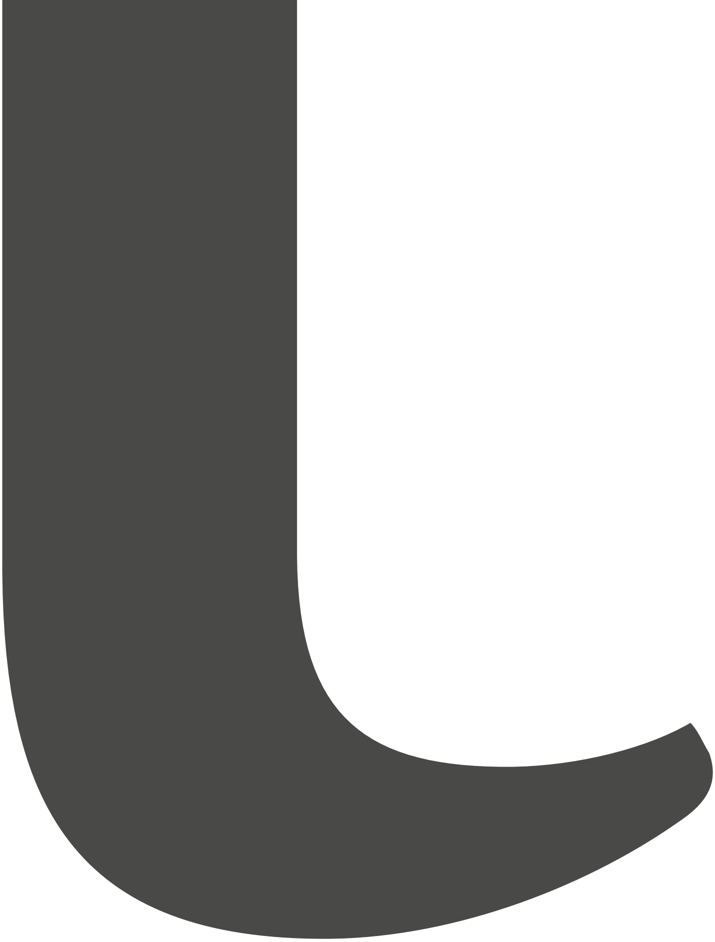


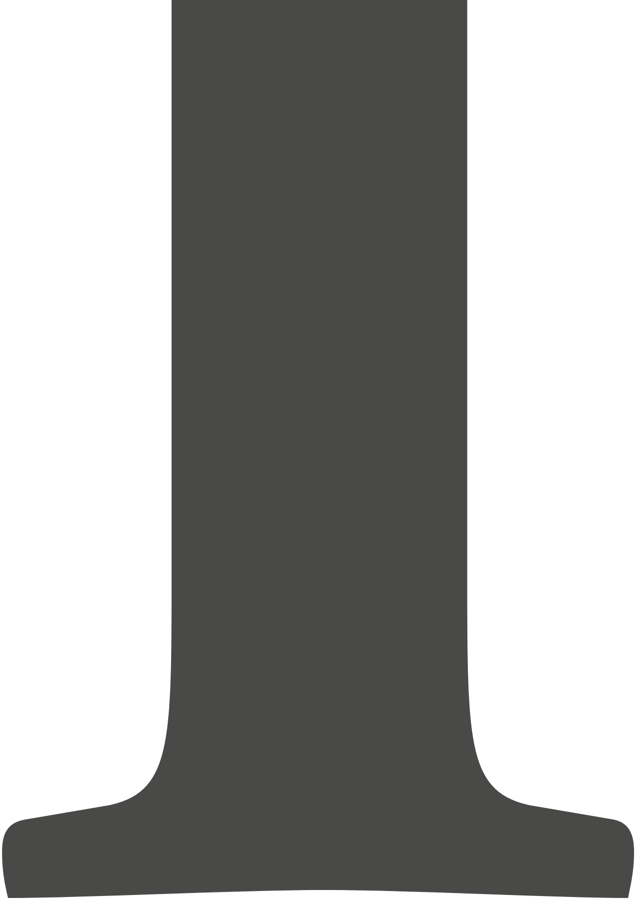


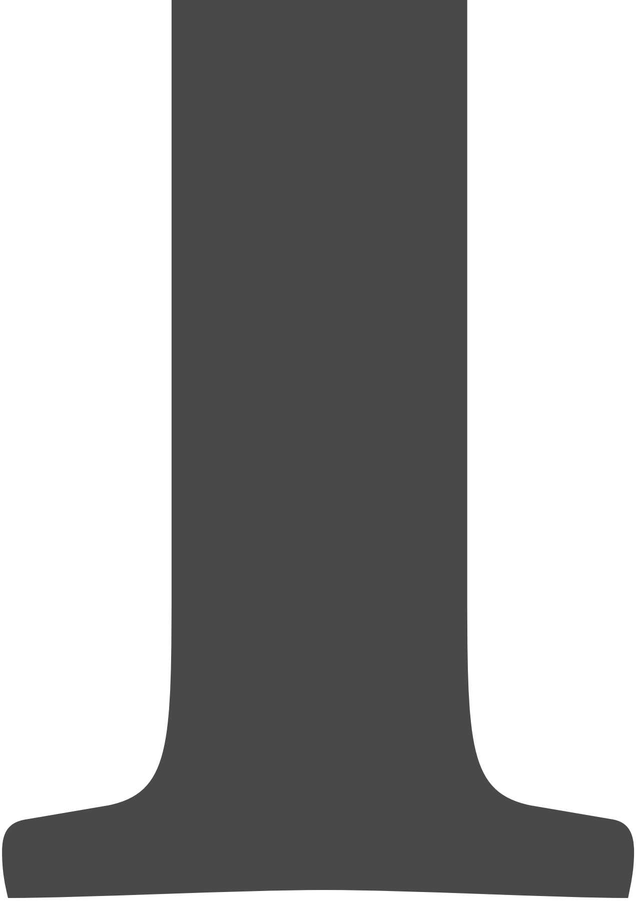
y

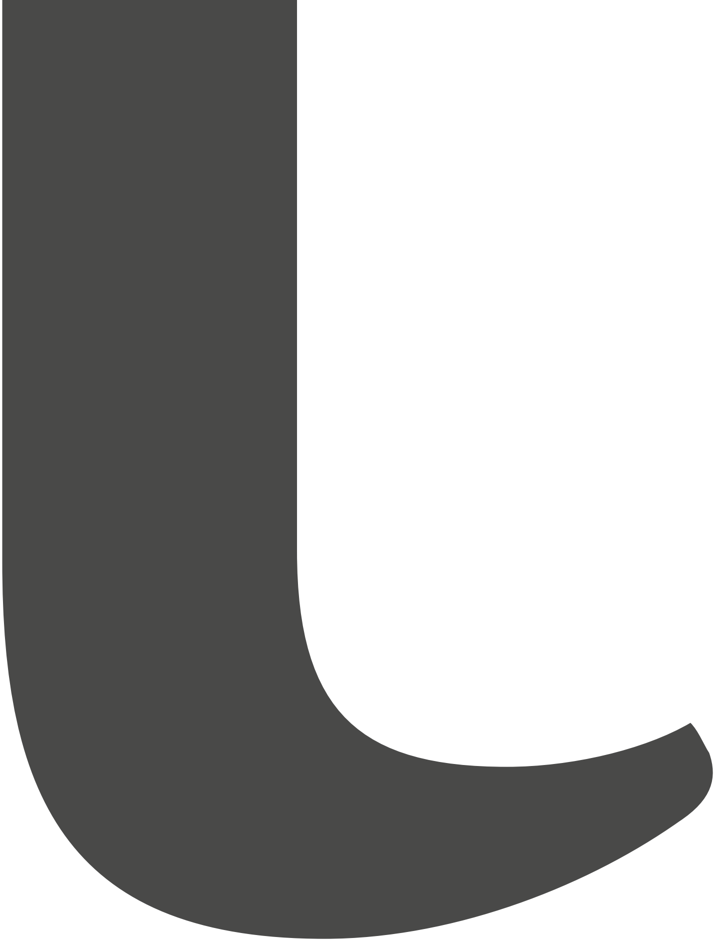


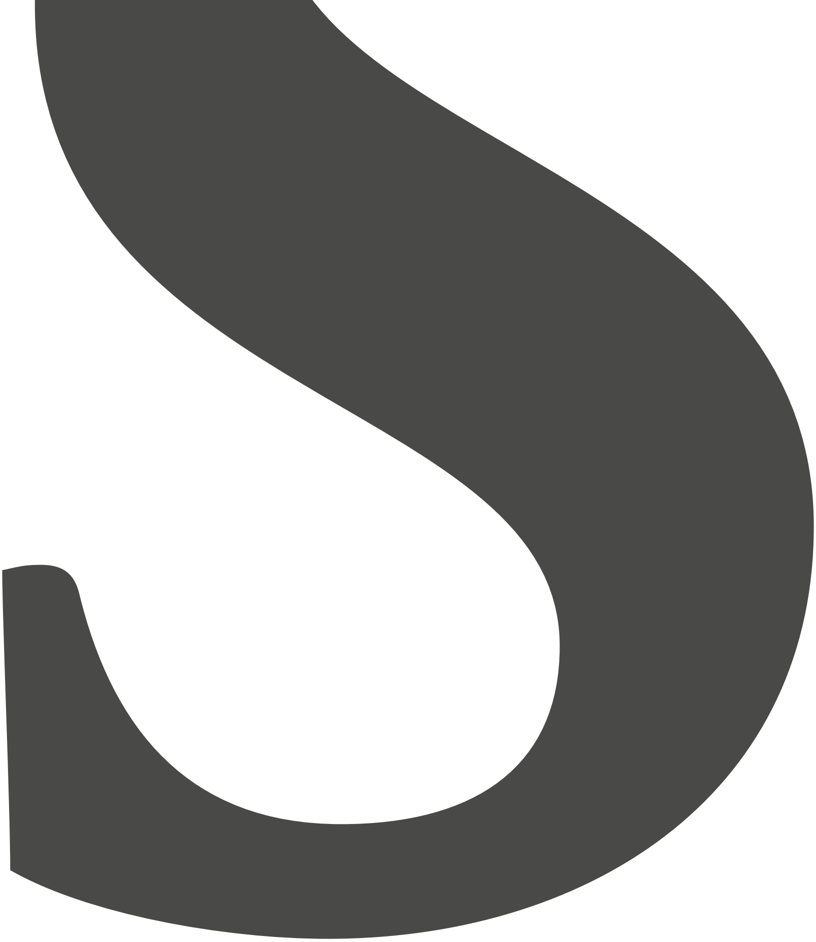






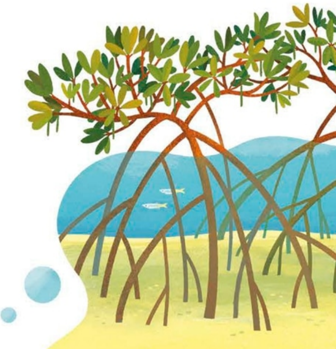






!

Mangrove

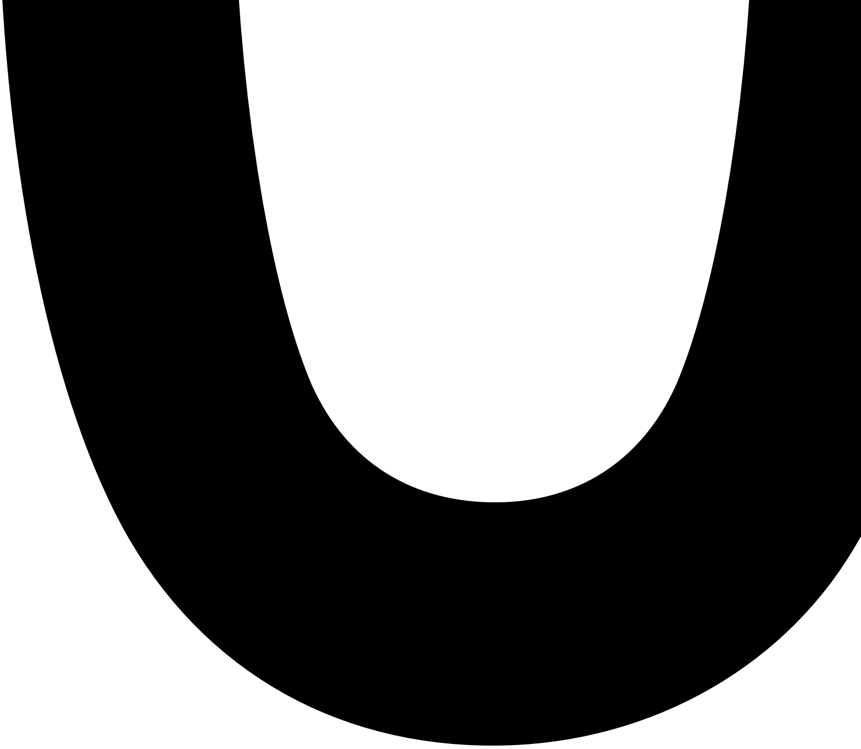


Red mangrov

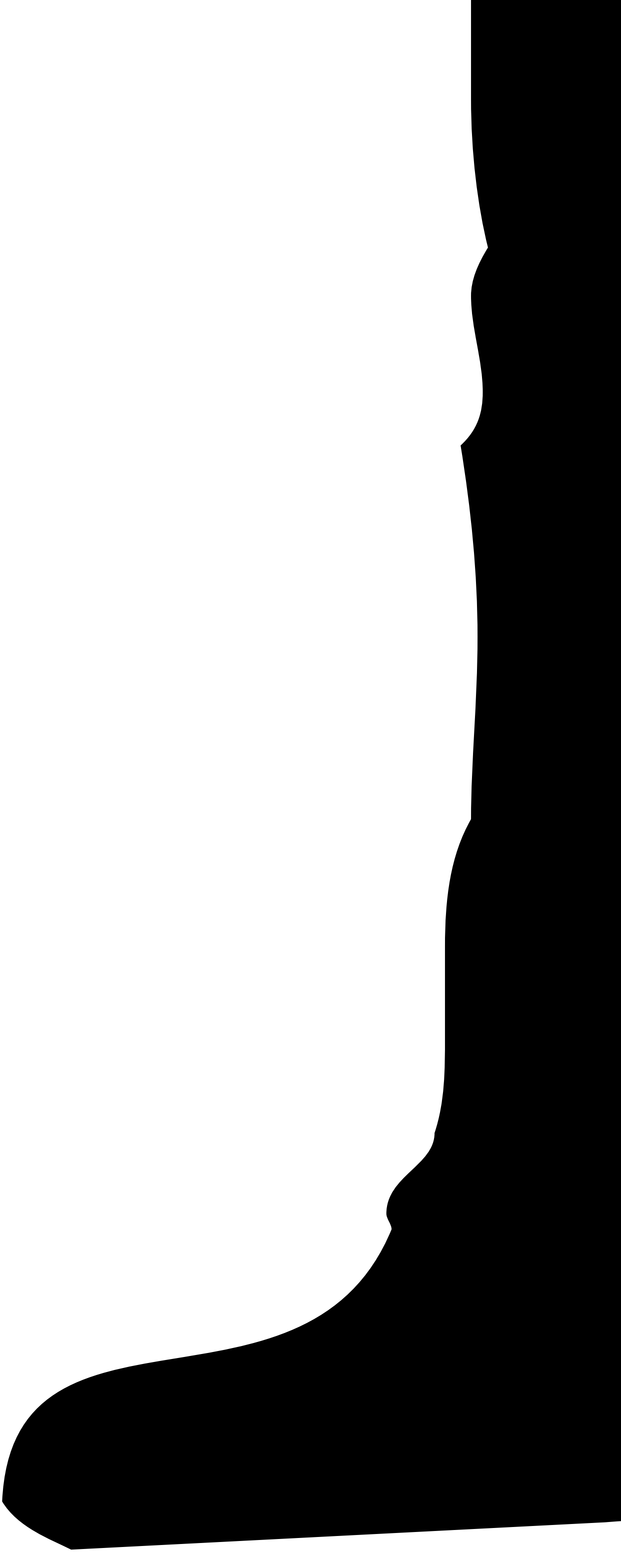
(Rhizophora mangle

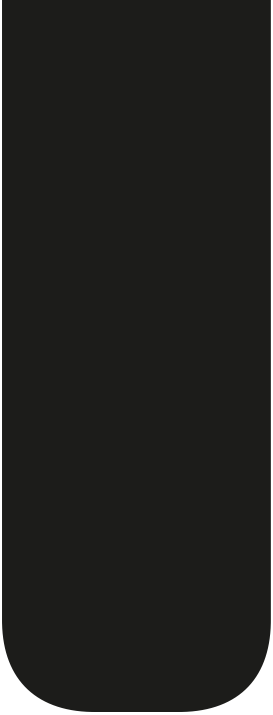
Forests of red mangroves
seen along many tropical
especially on both sides
Atlantic Ocean.

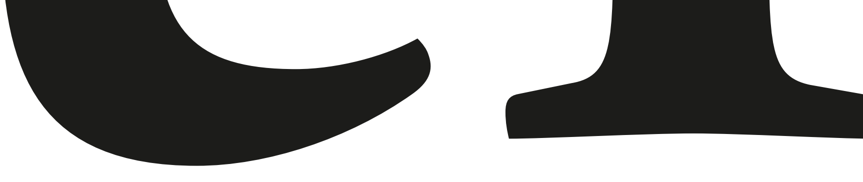
IV

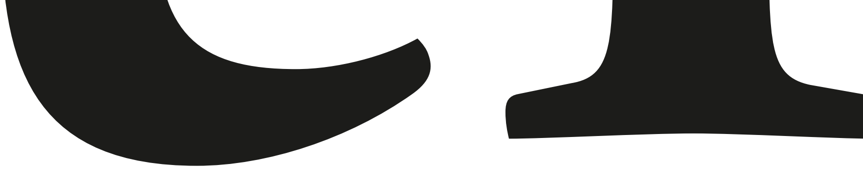


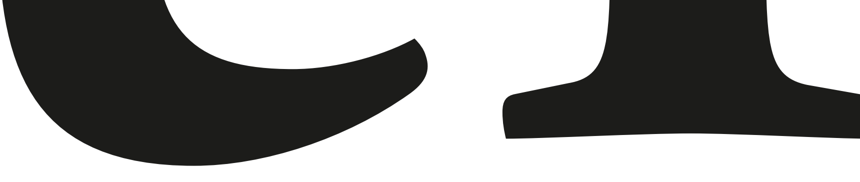
V











([illegible]

F

Se

e

A

H

fo

m

st

a

M

liv

st

A

th

lf

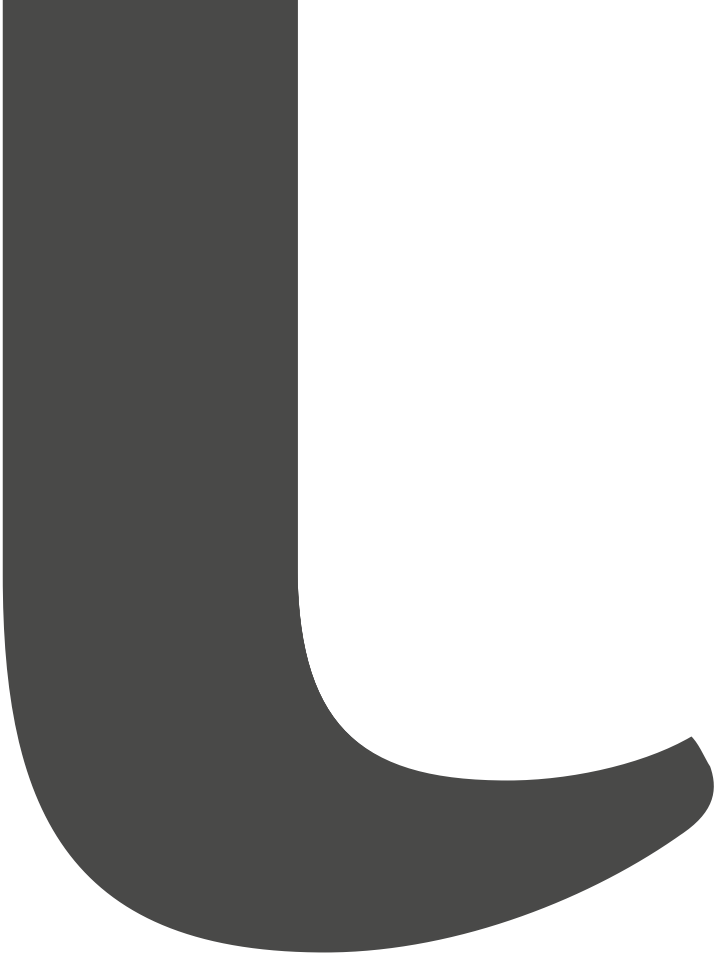
ro

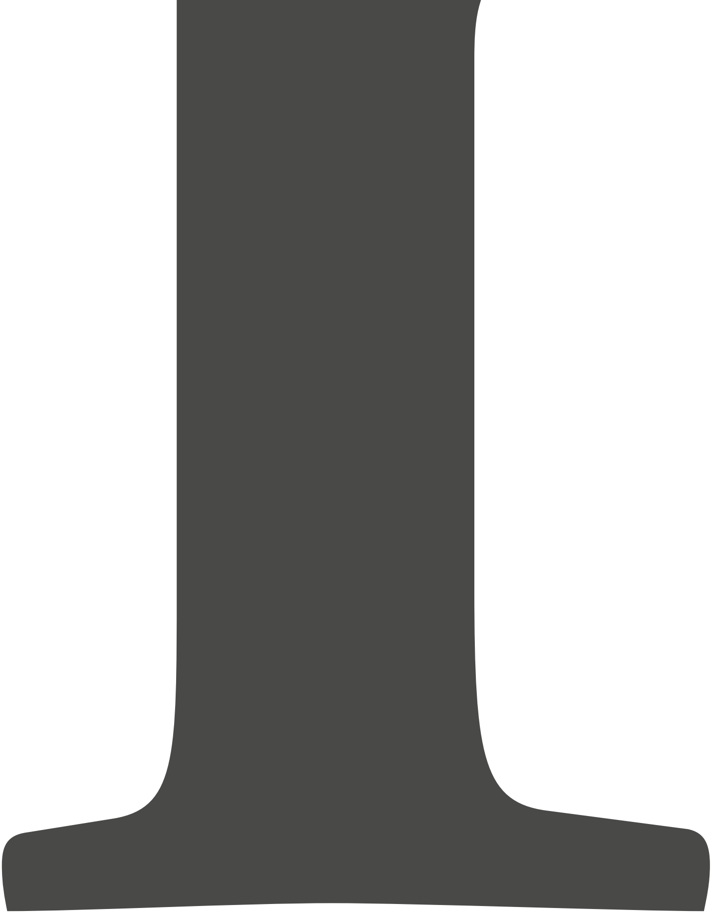
fi

C

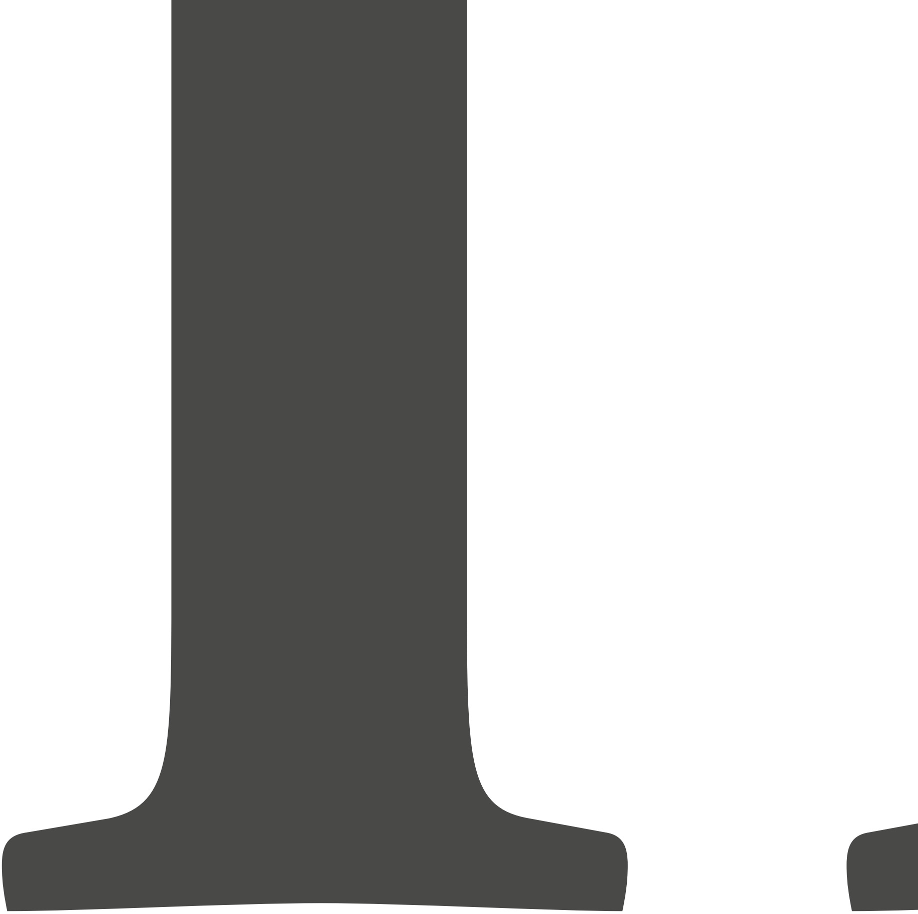
e

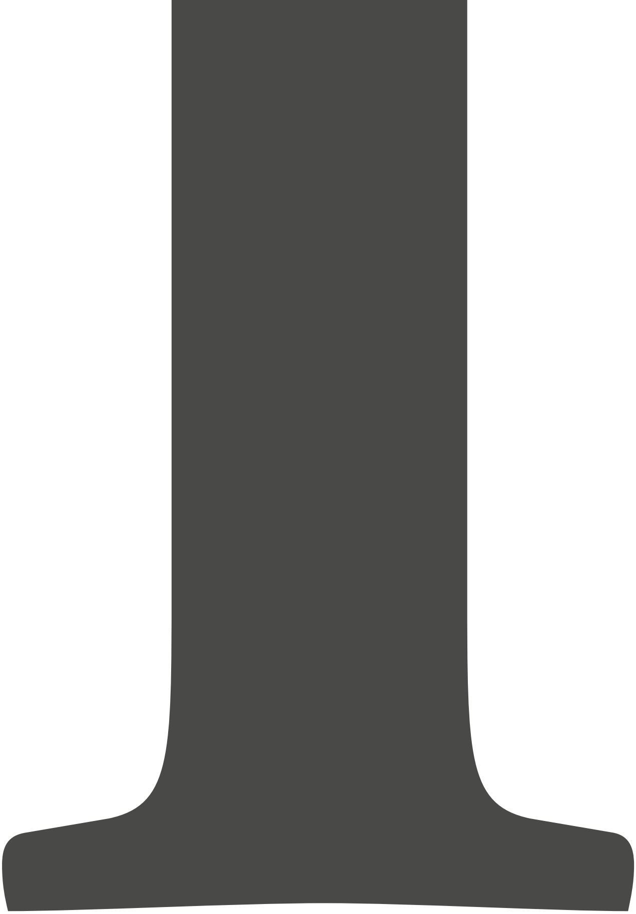
t

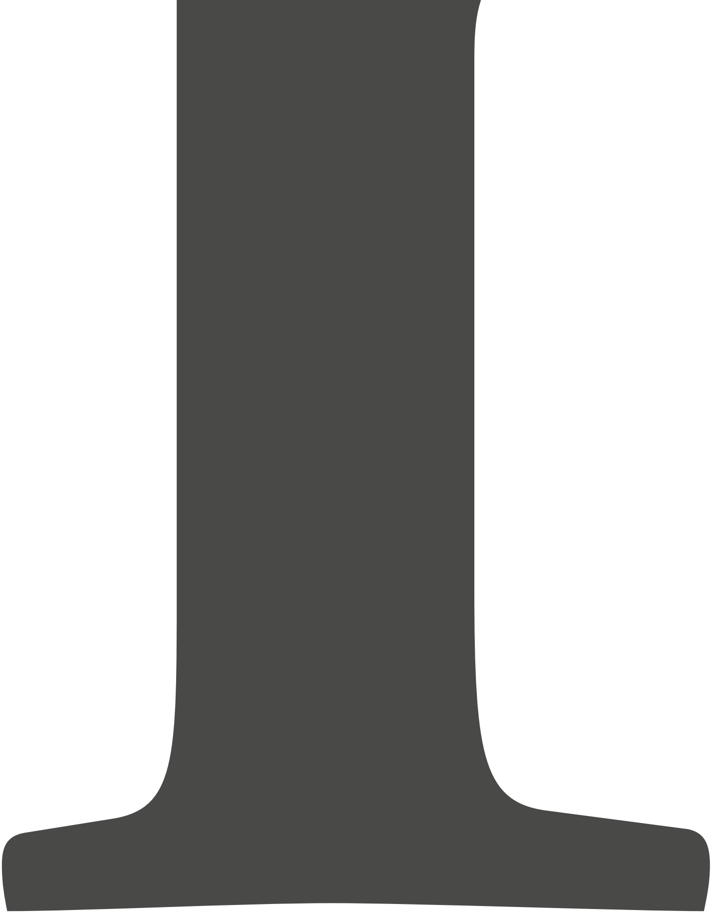


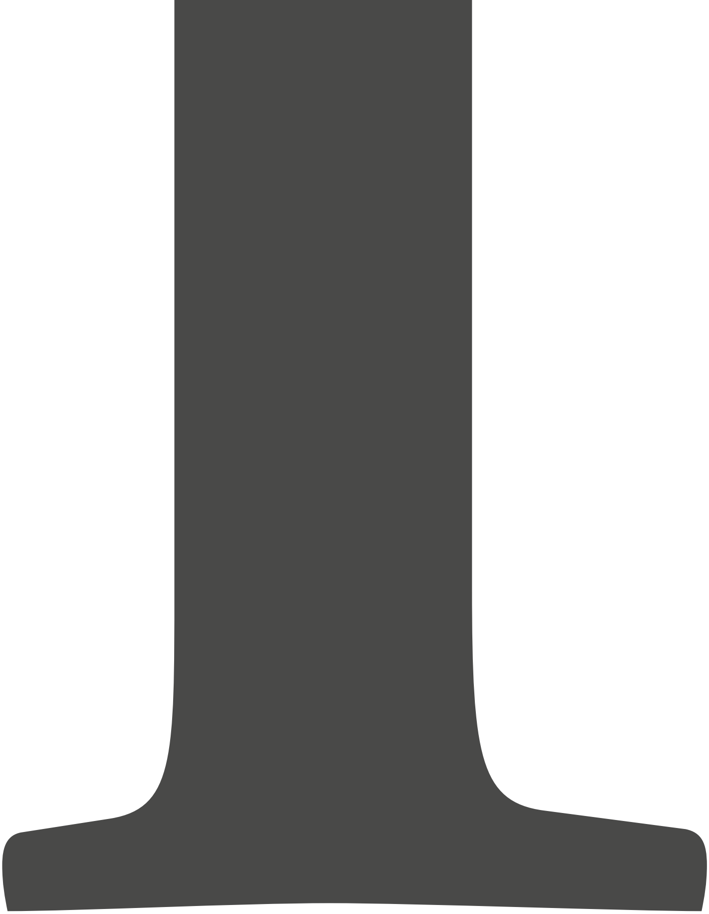


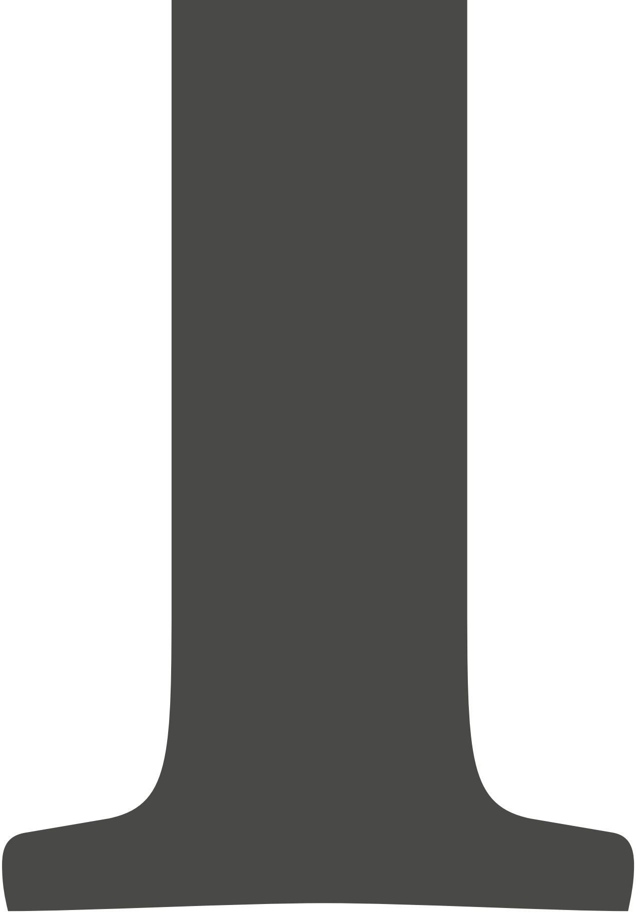
a

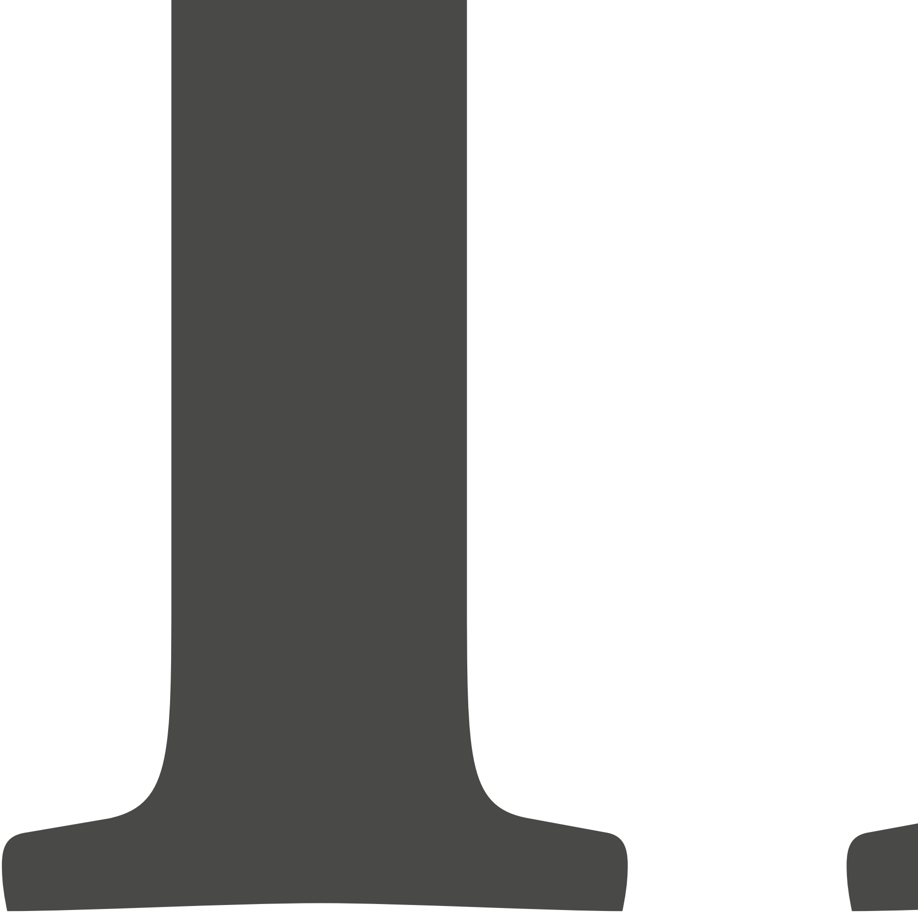




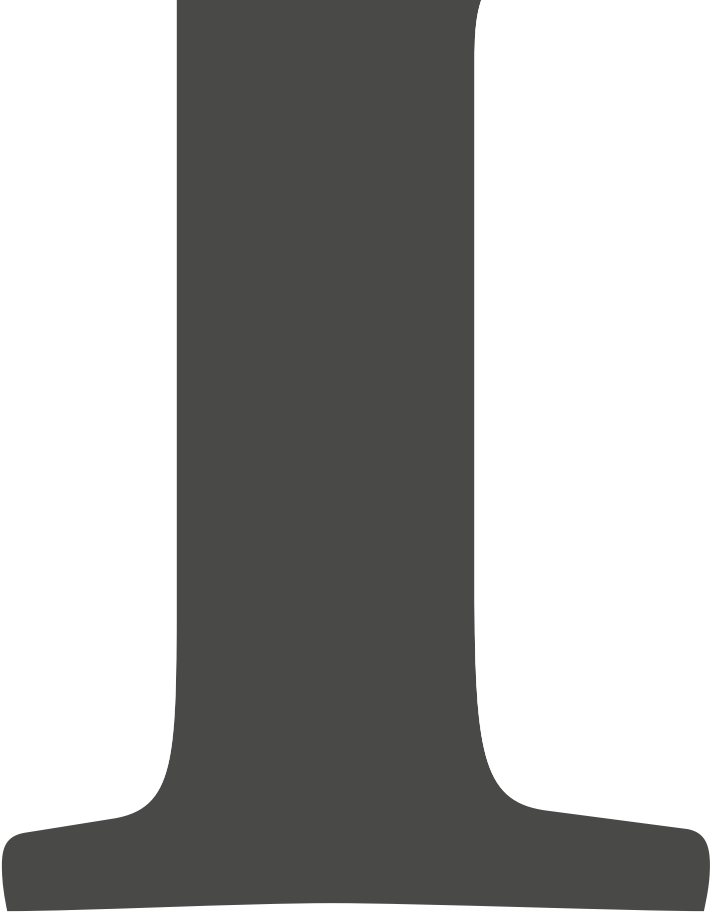


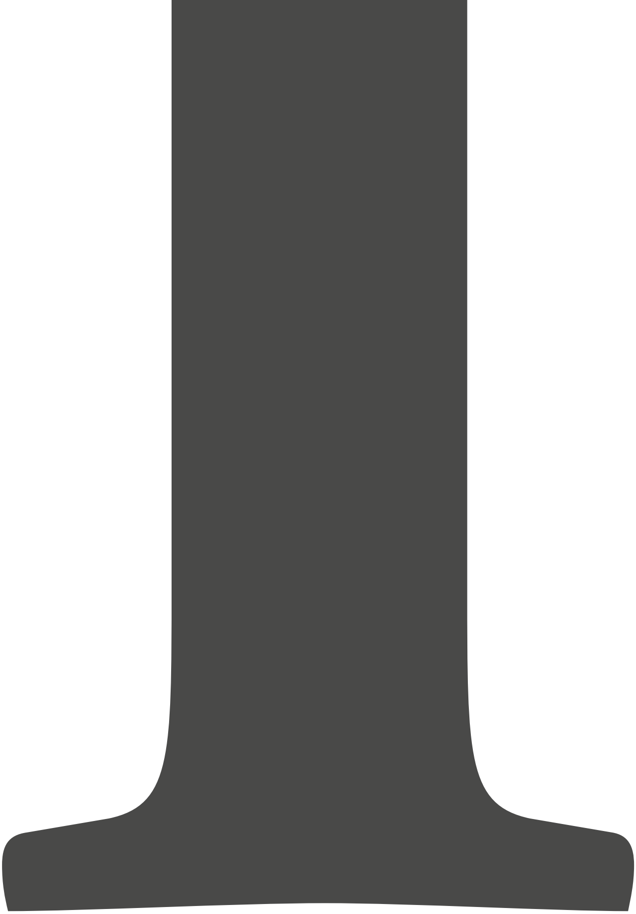


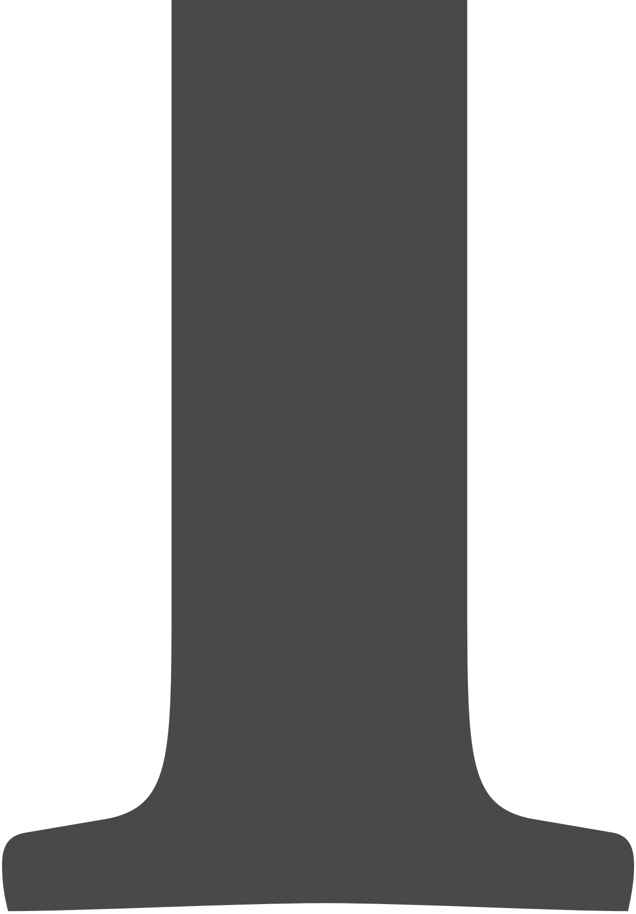


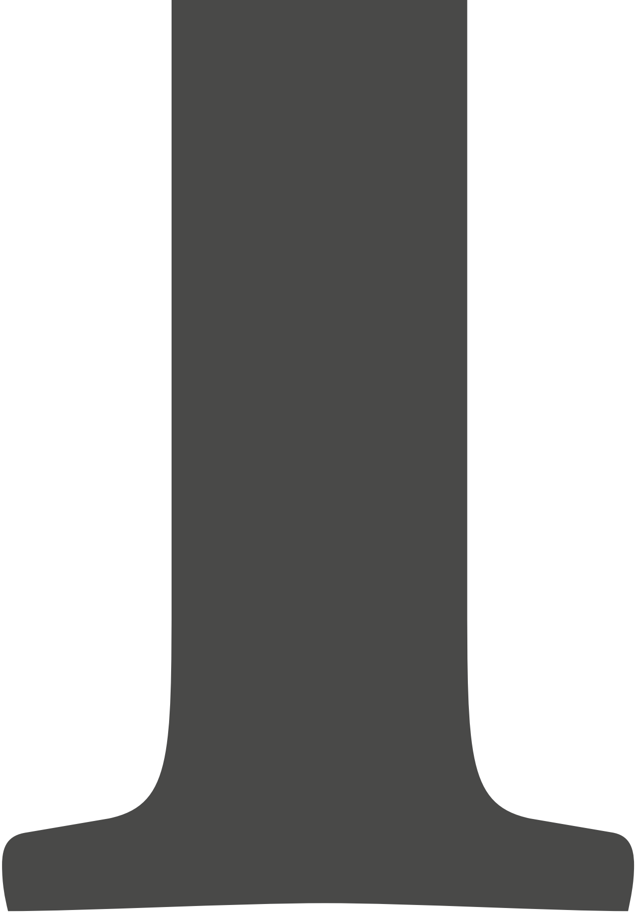


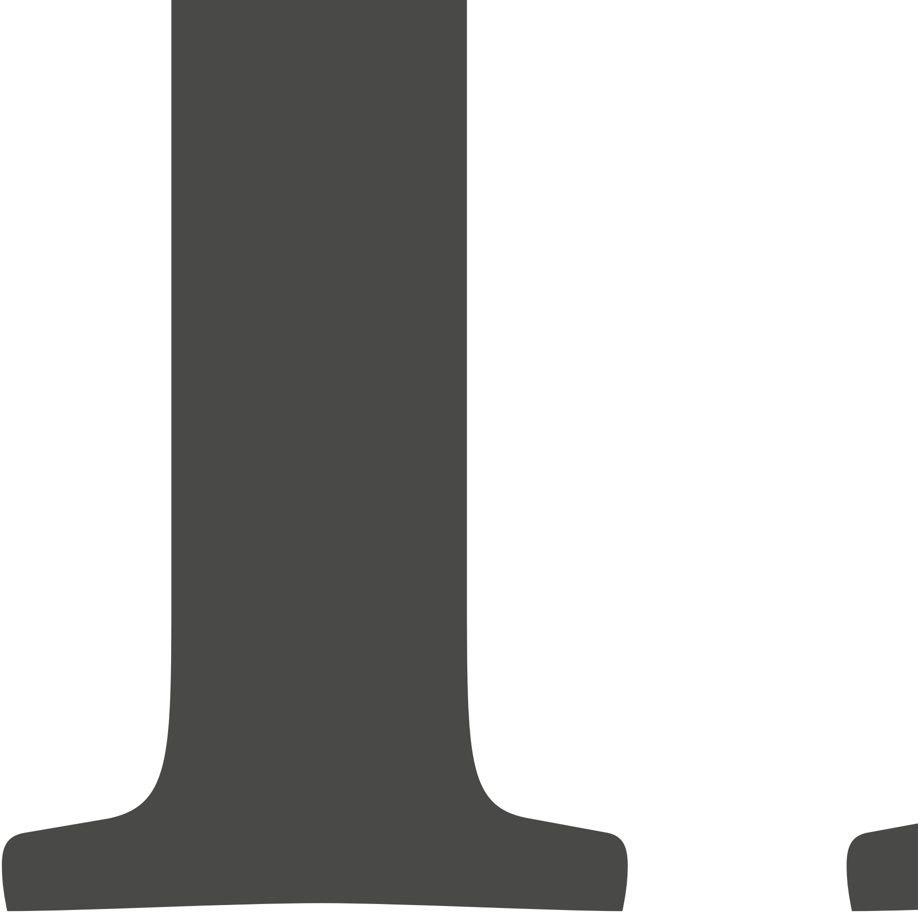
V



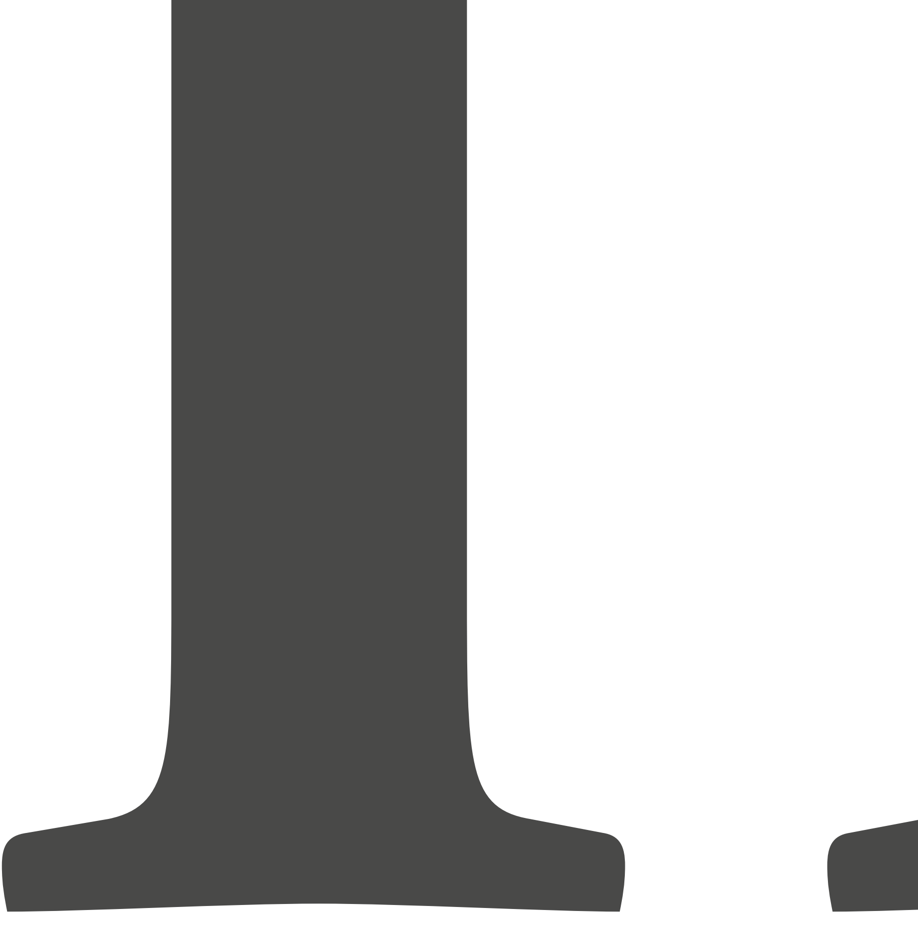


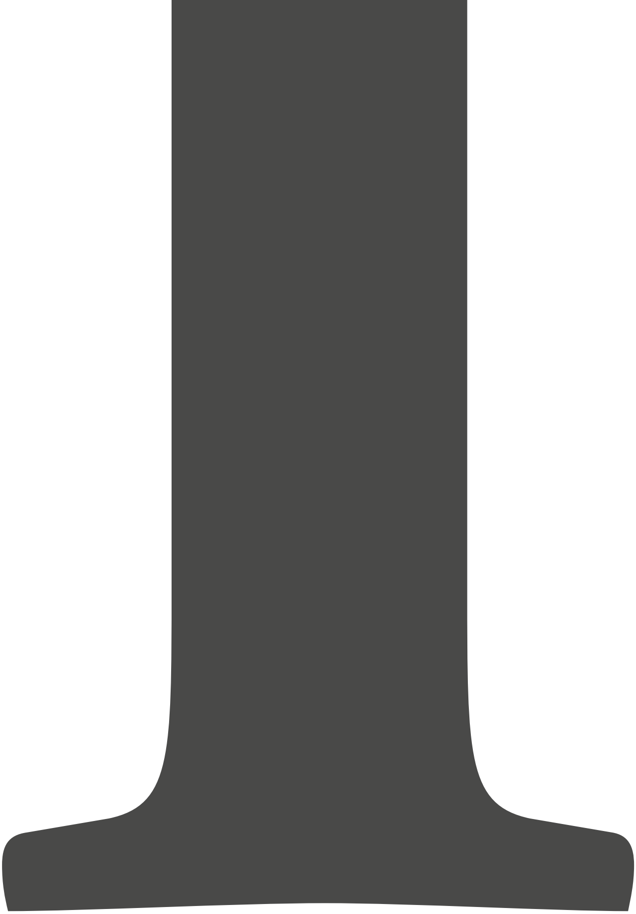


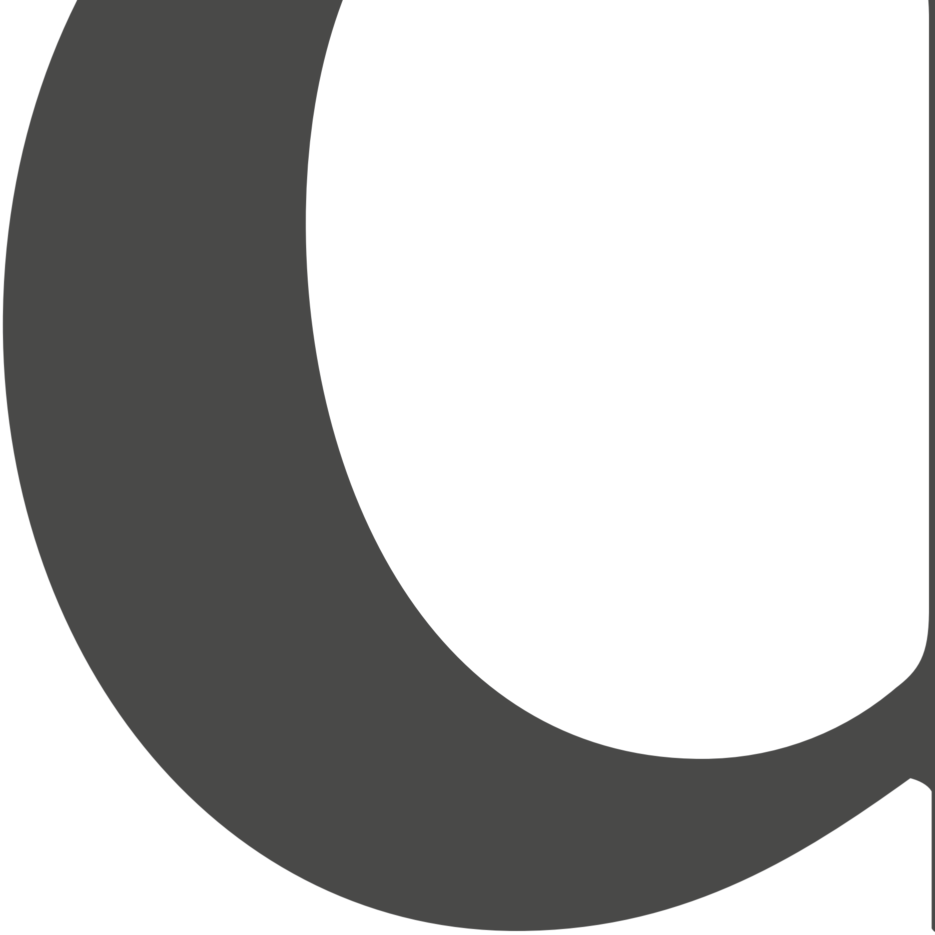


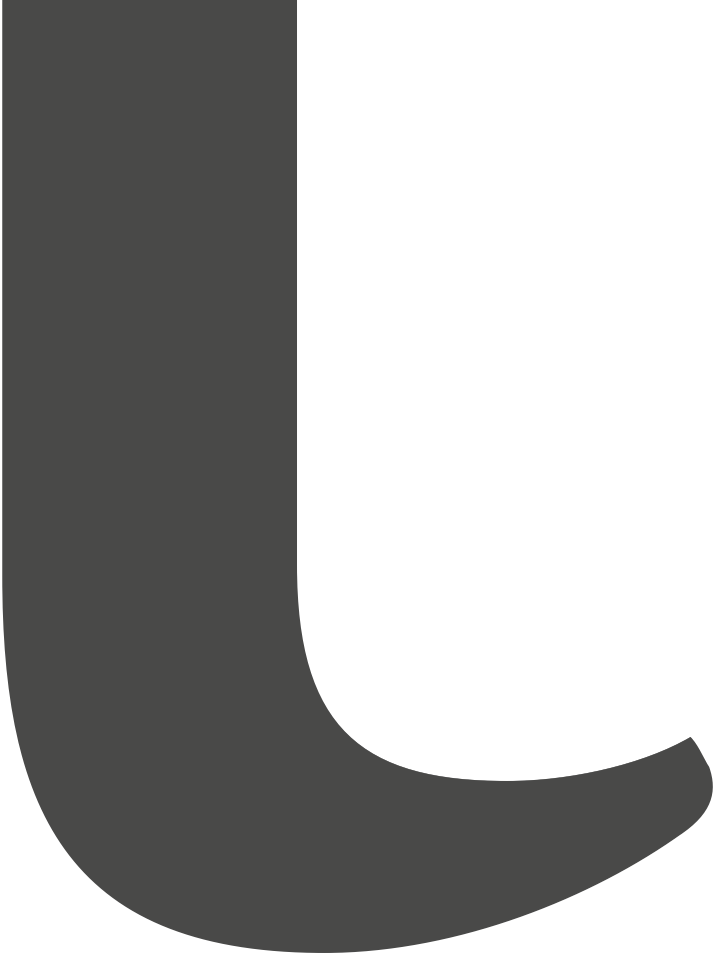


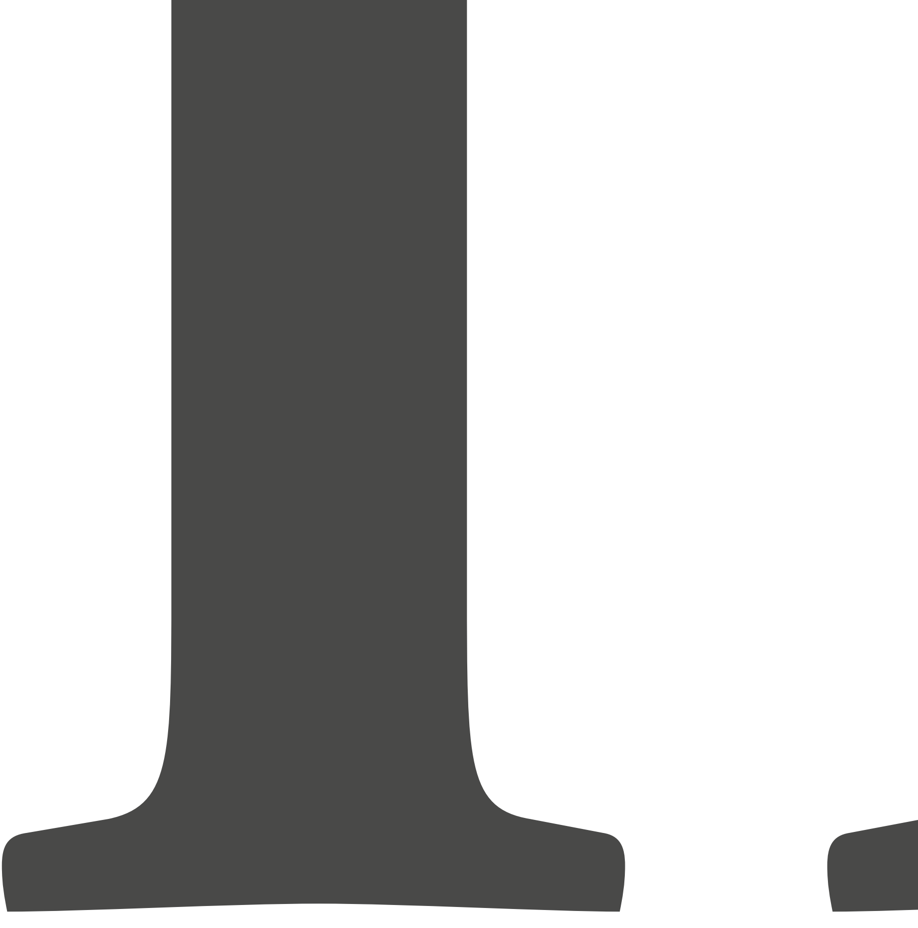
S

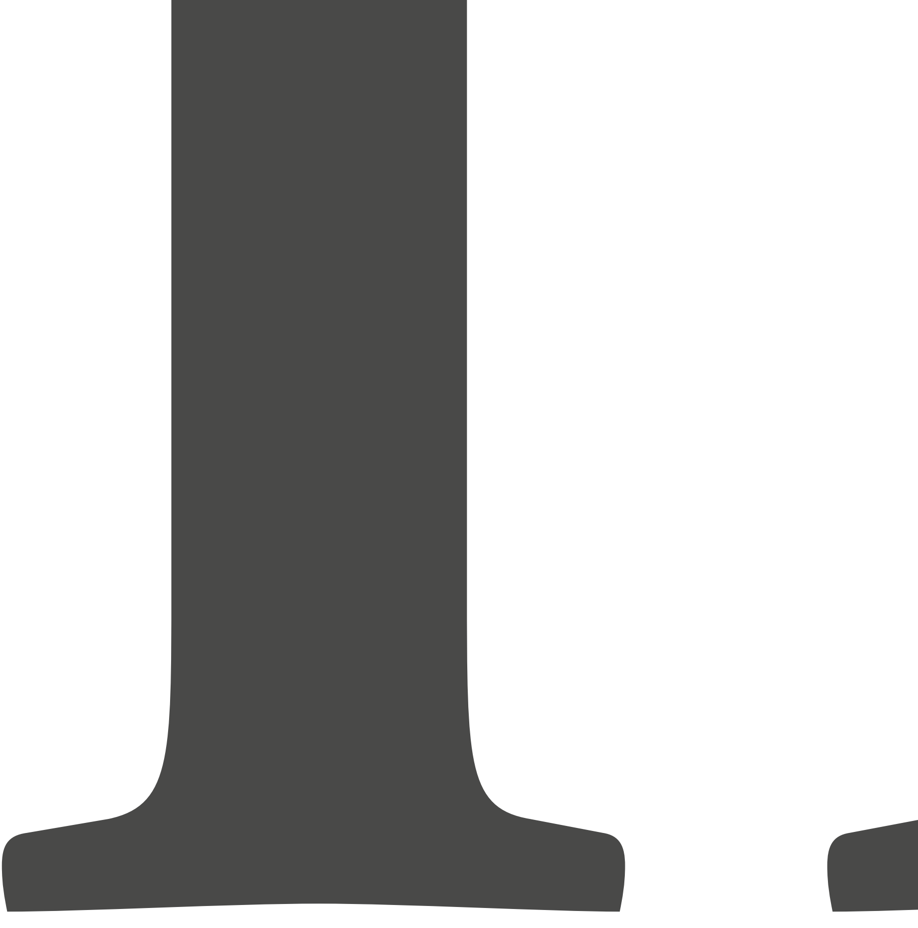


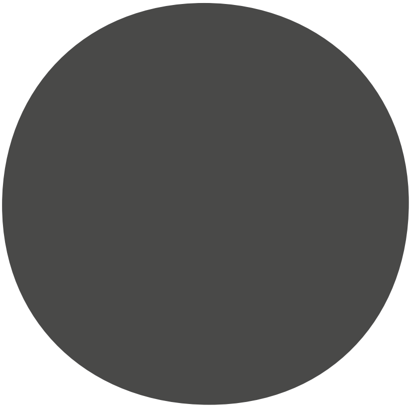




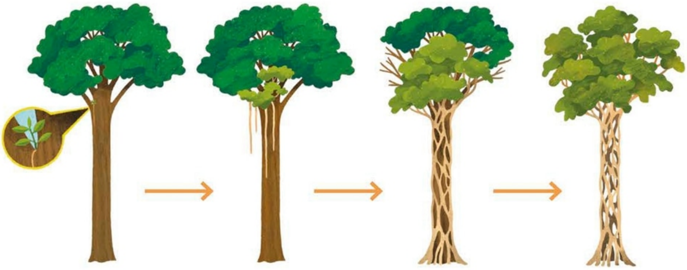






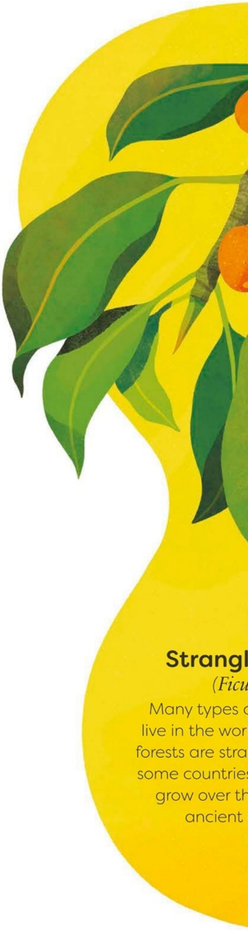


Strangler fig



Tree takeover

A strangler fig sends its roots down a tree from the top. The roots can surround the trunk completely to reach the ground. If the tree dies, all that's left is the tower of fig roots, with the fig's leaves at the top.



Strangl

(Ficu

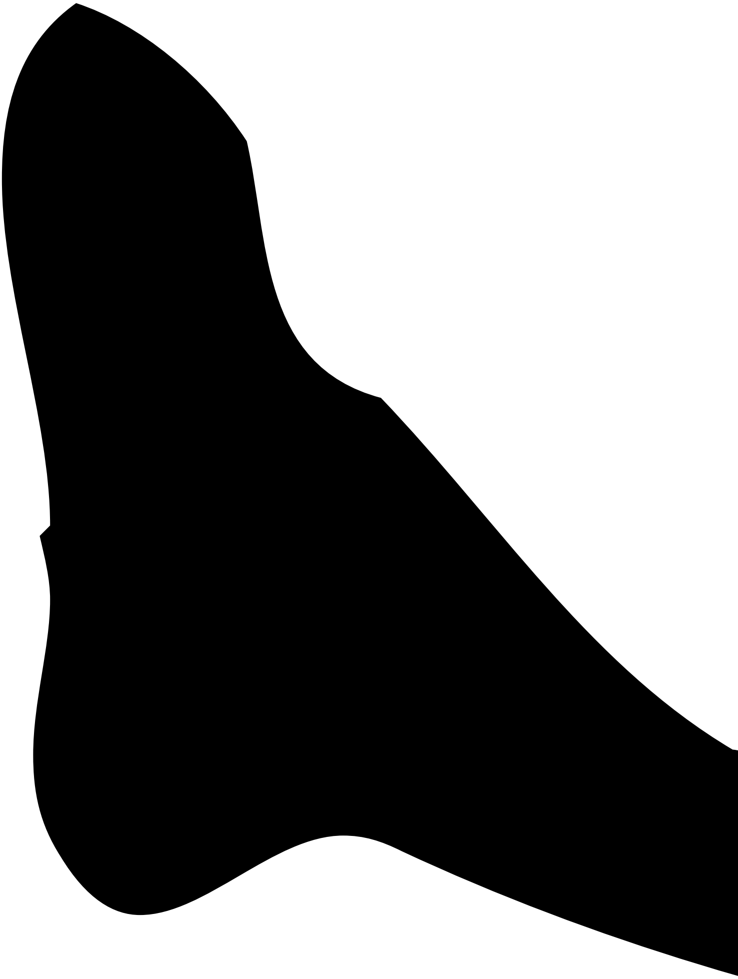
Many types o
live in the wor
forests are stra
some countries
grow over th
ancient

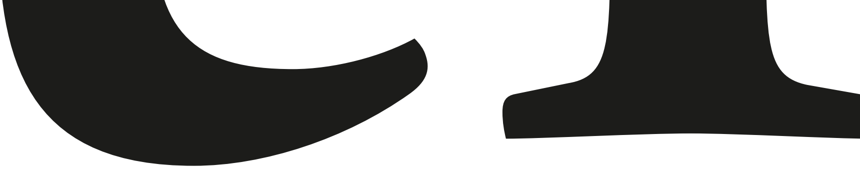
0

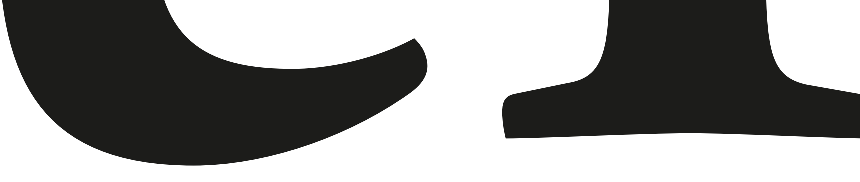
[redacted]

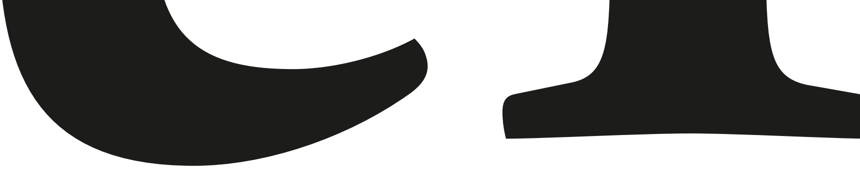
G

[redacted]









A

d

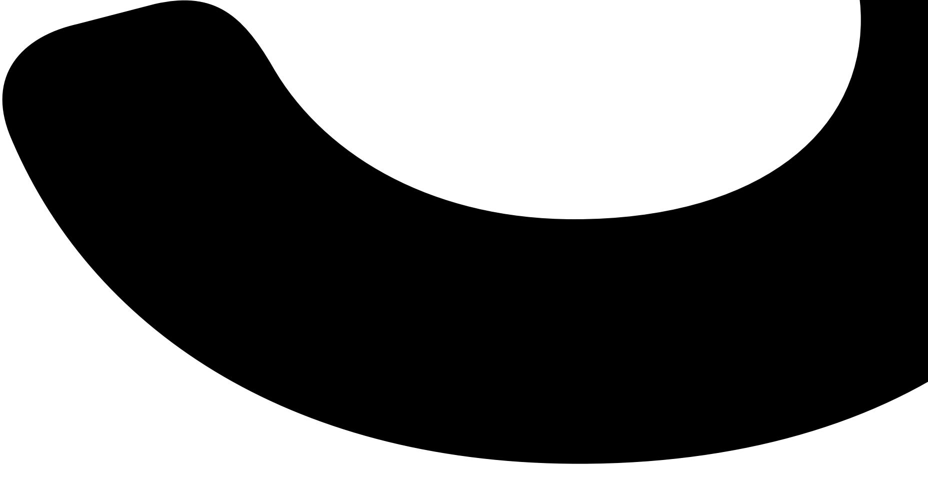
T

C

lf

th

fi



([illegible]

M

liv

f

S

g

a

T

F

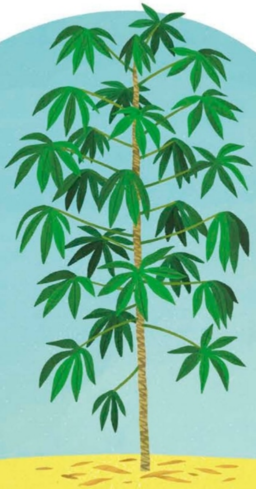
sp

F

tr

T

Cassava



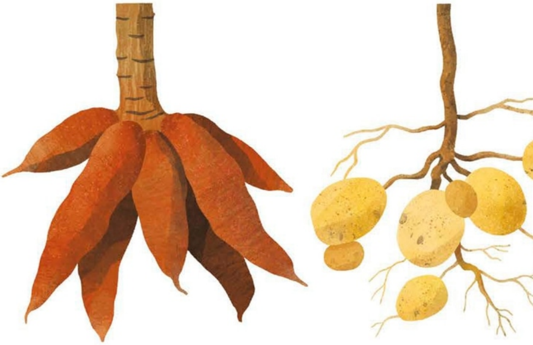
Cassava

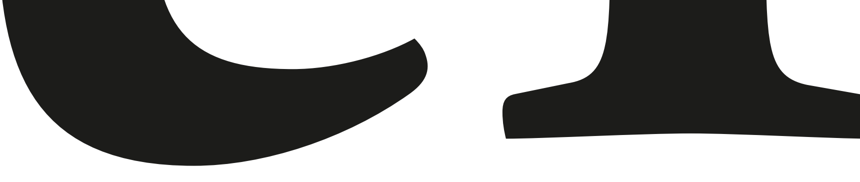
(Manihot esculenta)

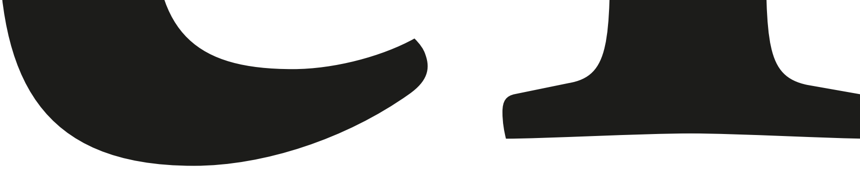
Fields of cassava are a familiar sight in many tropical regions. The main variety grown today originally came from Brazil.

Roots or stems?

As they mature, cassava plants begin to store food and water in their roots, which fatten up in bunches in the soil. Potatoes look similar, but they are in fact massively swollen stems that grow underground at the base of the potato plant.







A

b

th

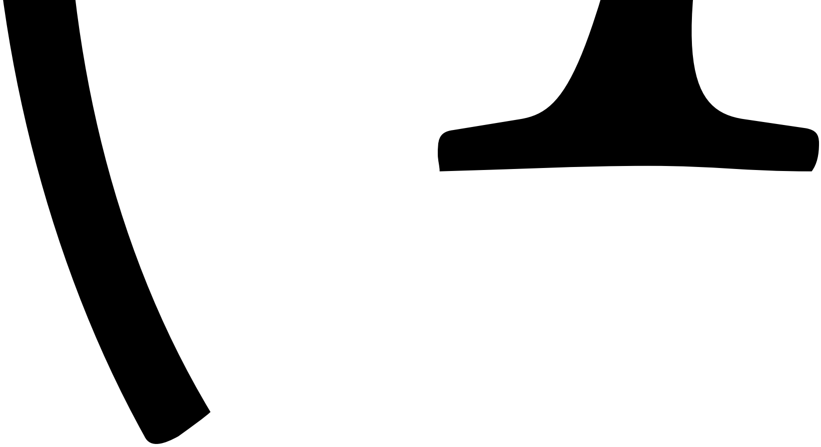
b

lo

m

g

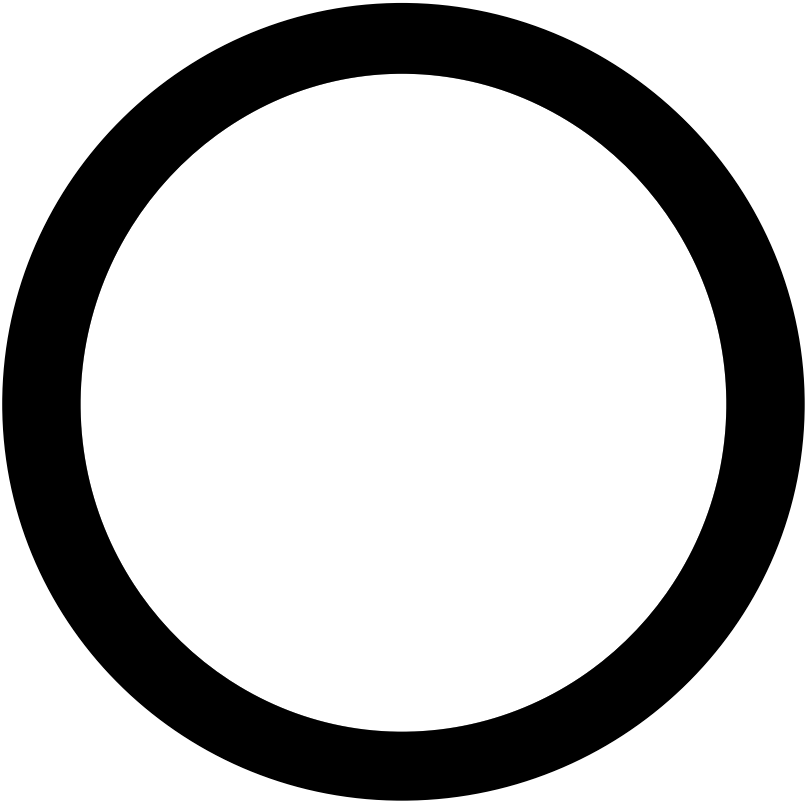
O



F

Si

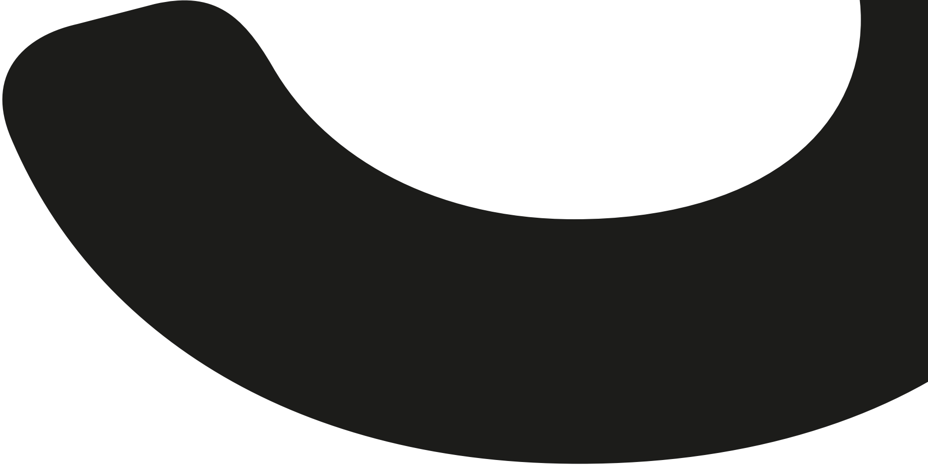
T



C

C

V



W

fl

st

th

re

R

T

d

p

m

C

a

T

e

st

C

Th

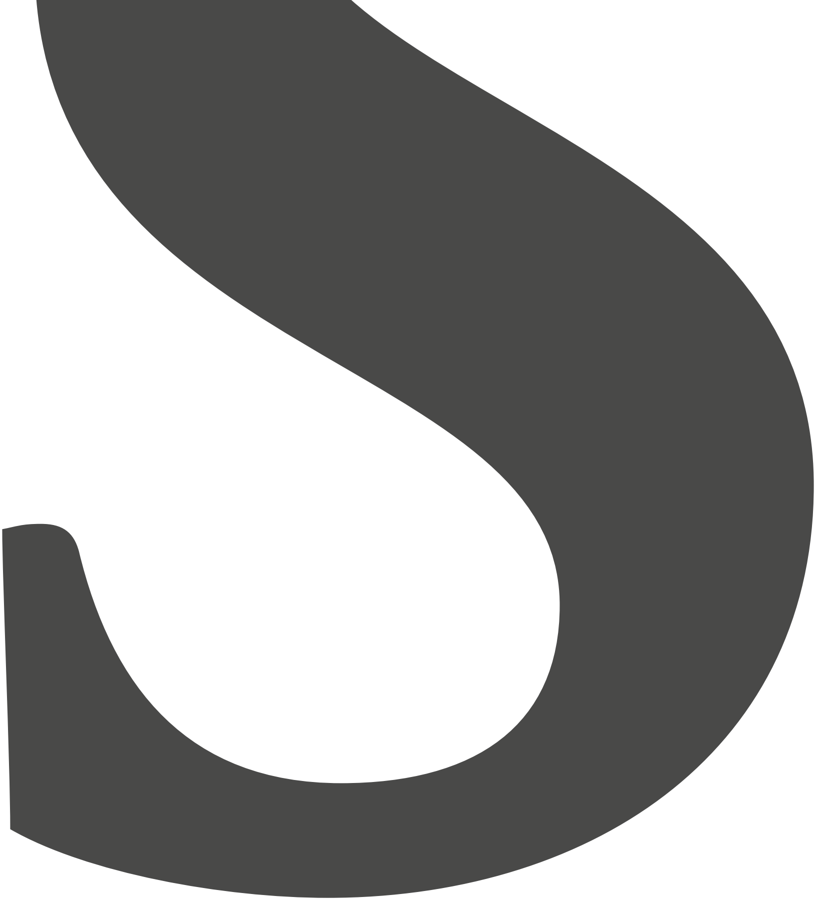
g

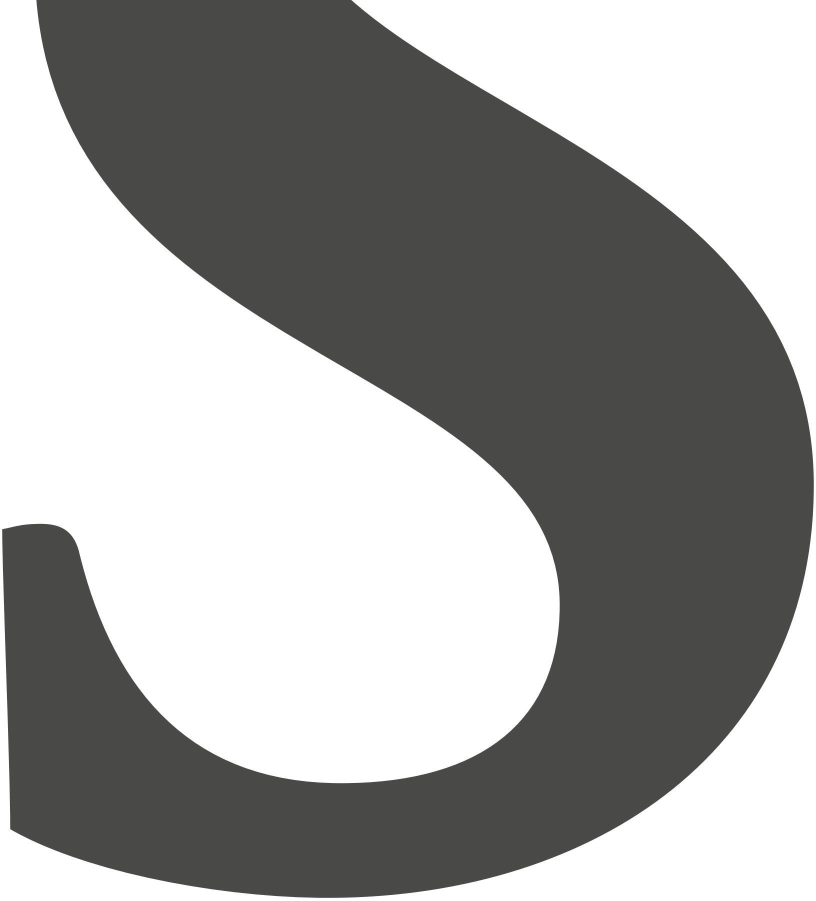
F

tu

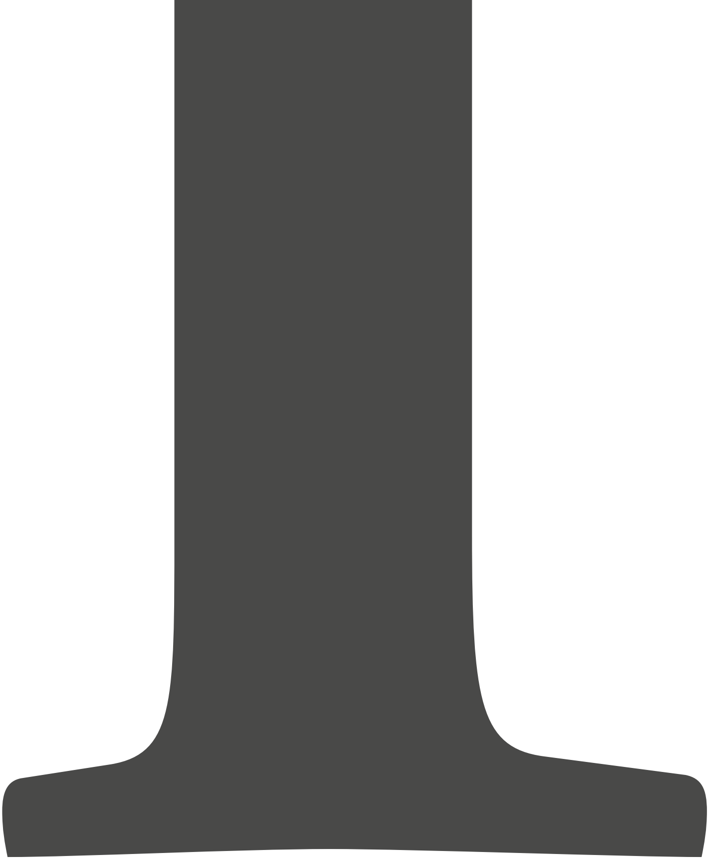
b

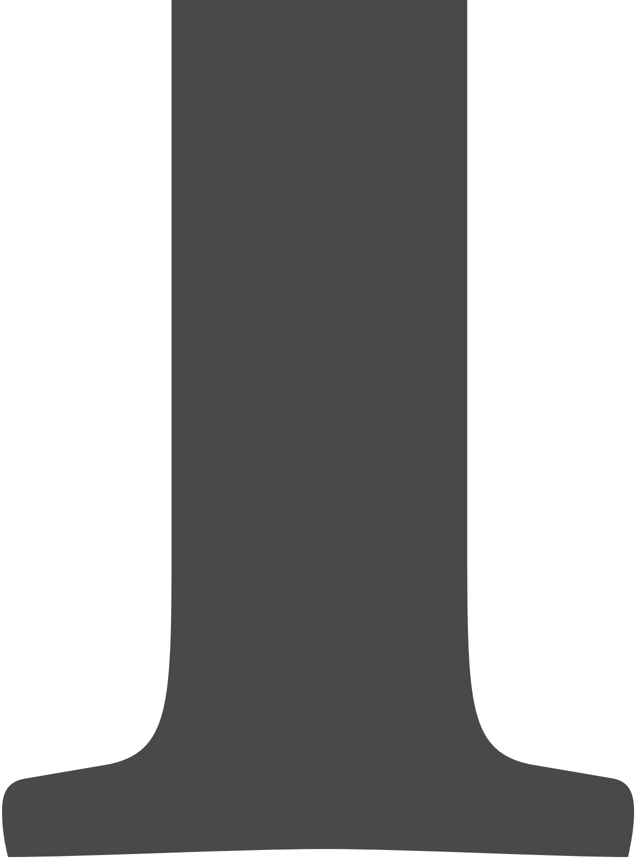
a

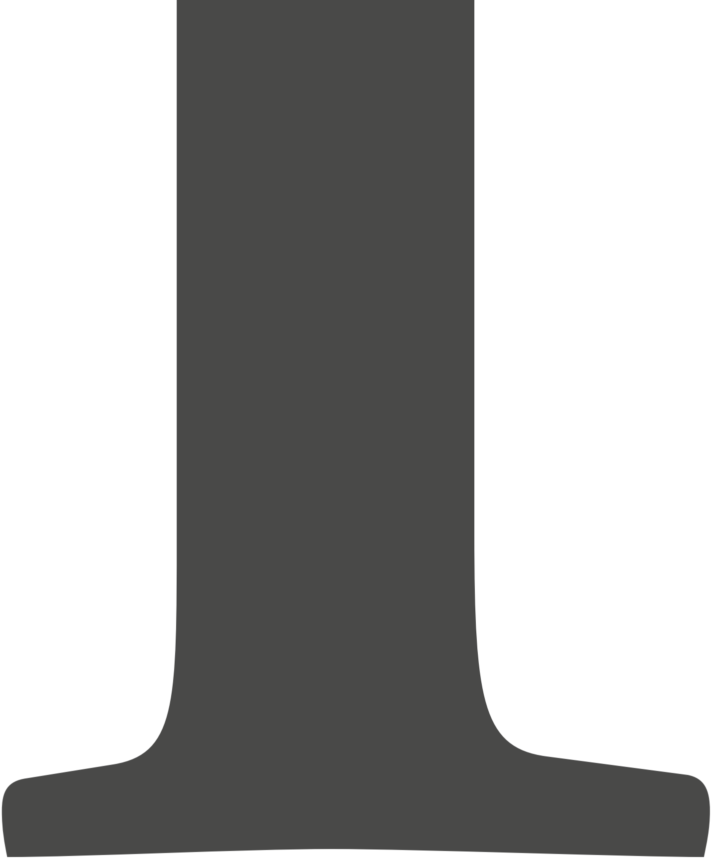


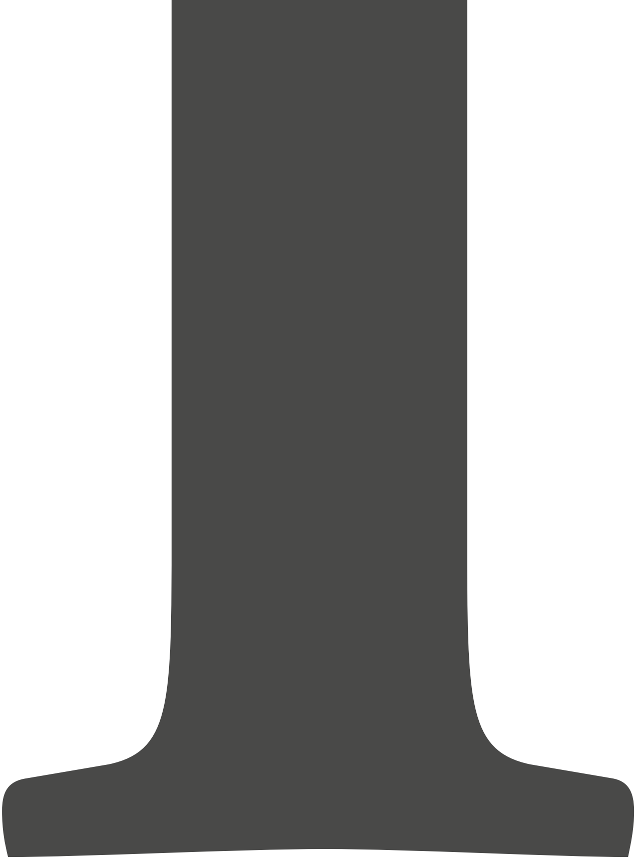


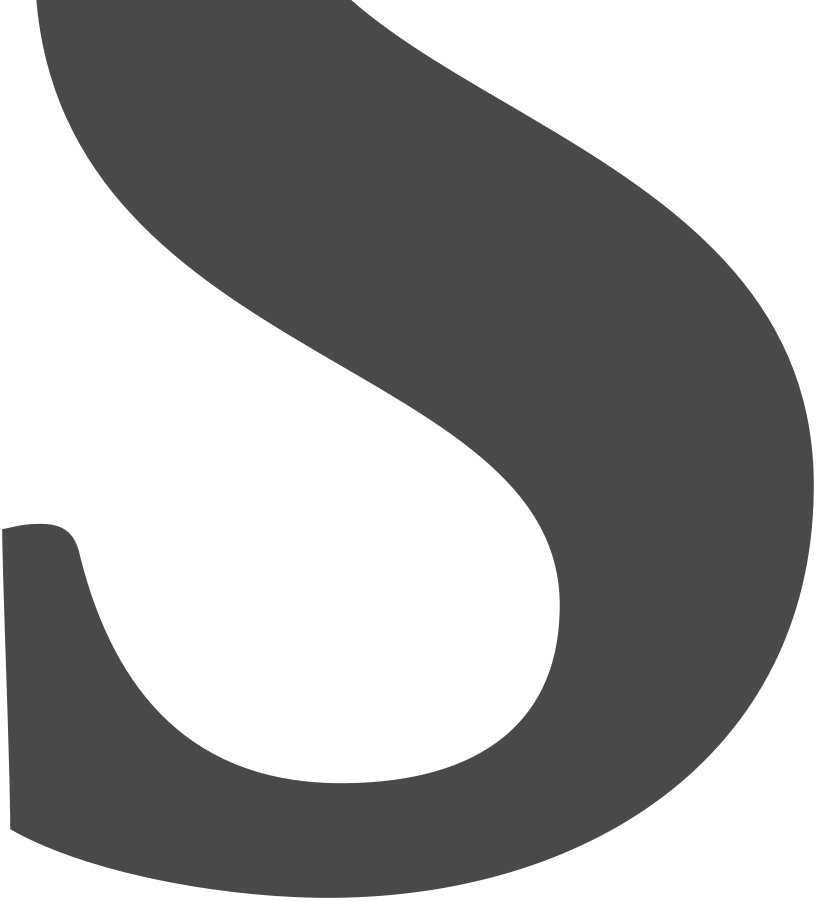
V

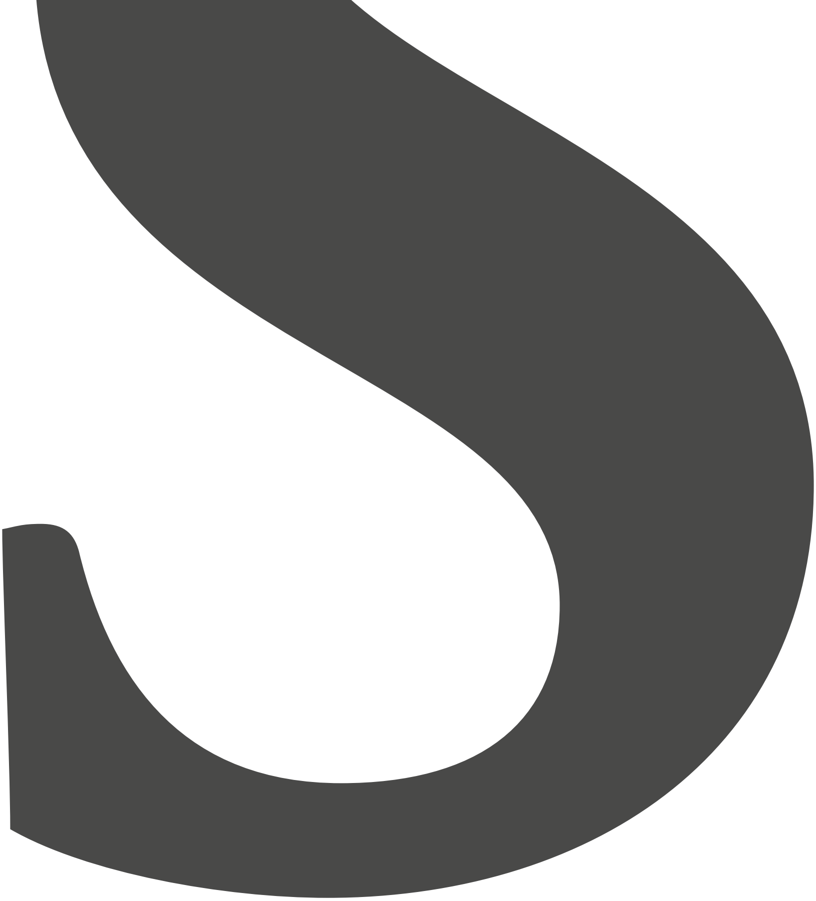


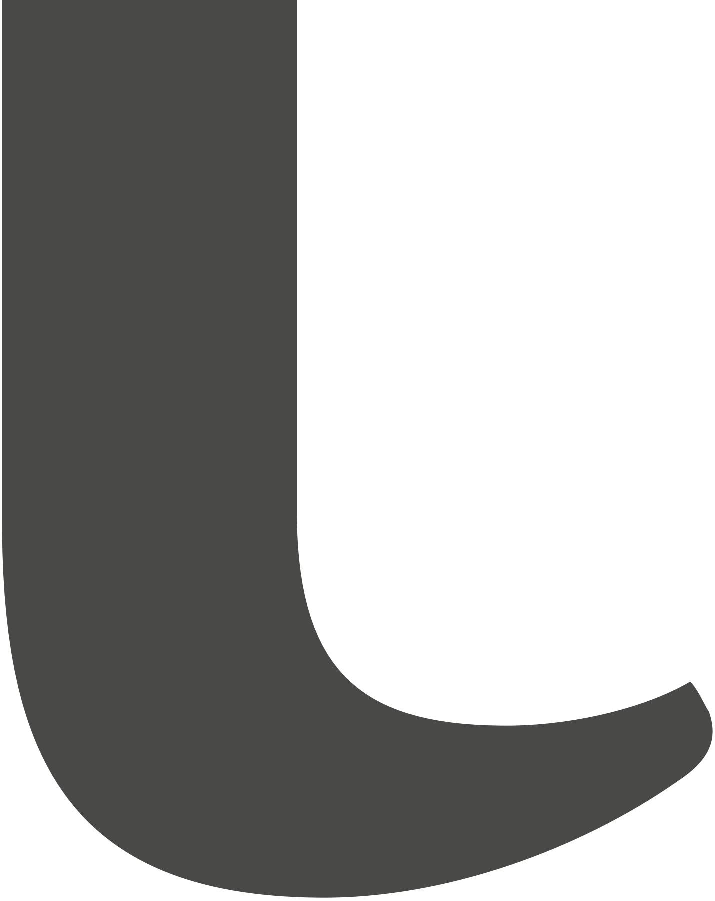


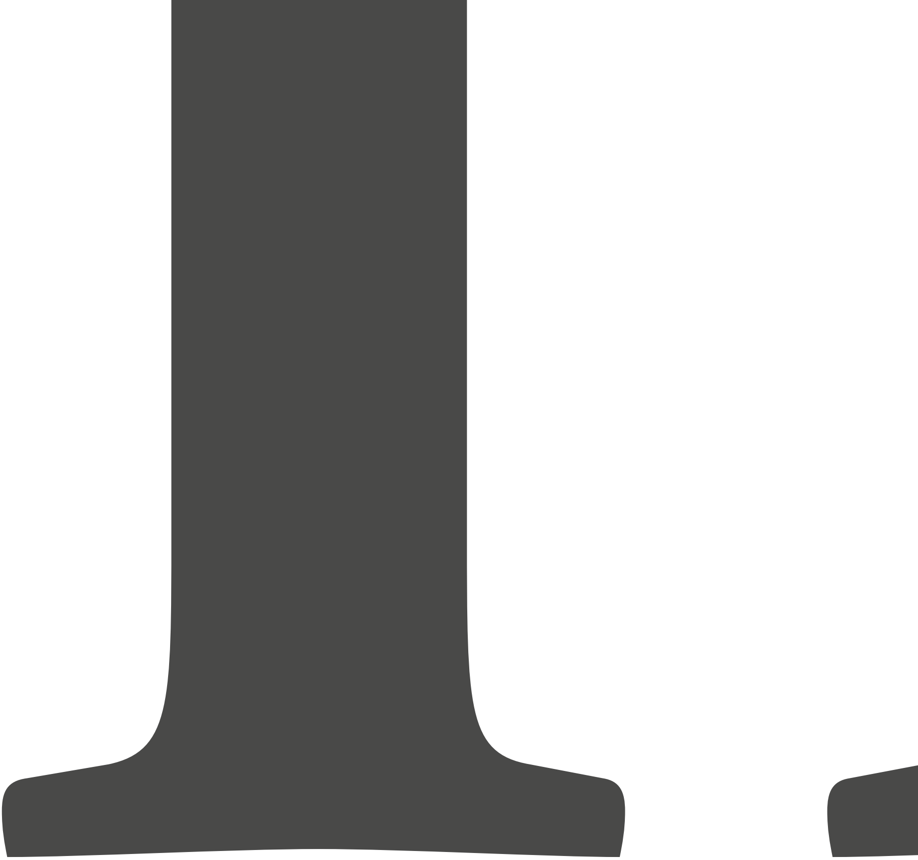




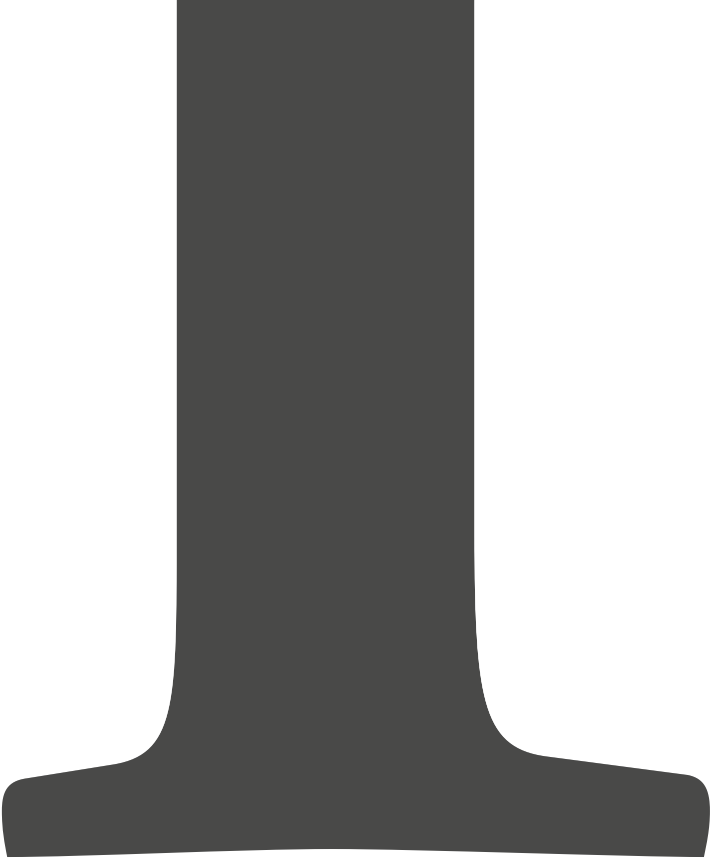




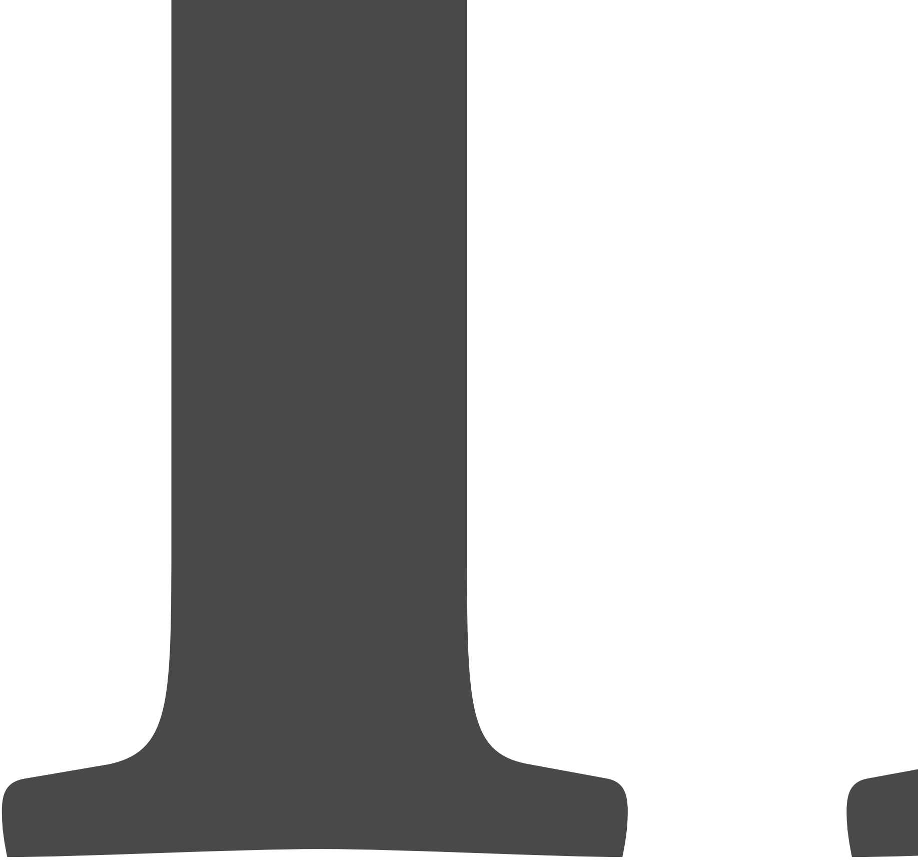




K

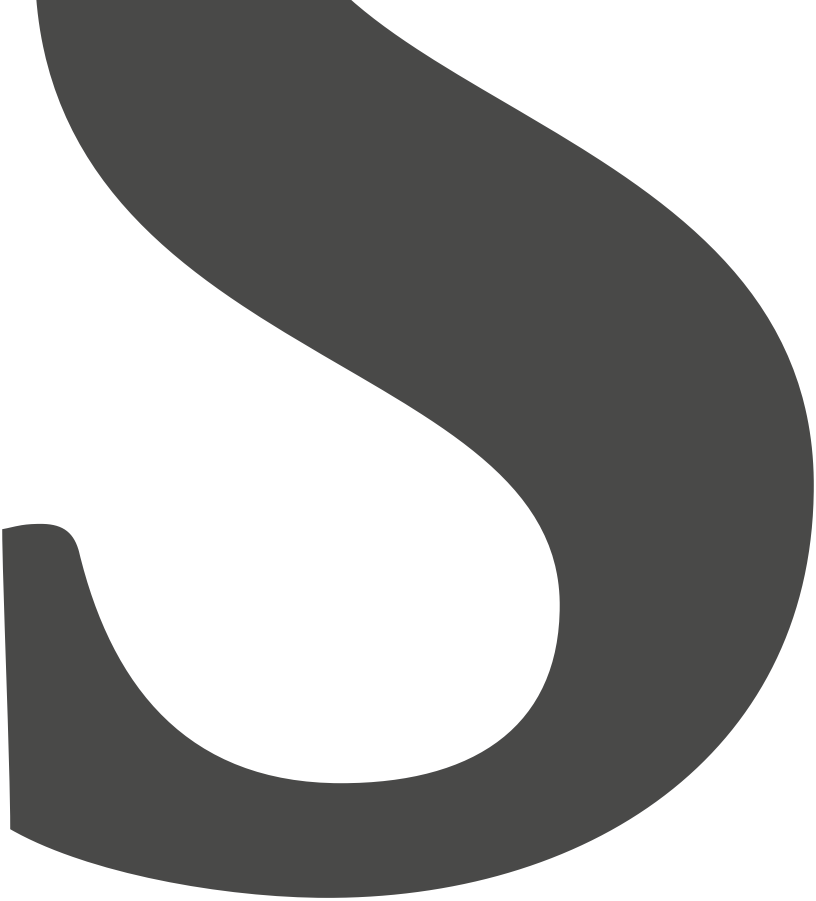


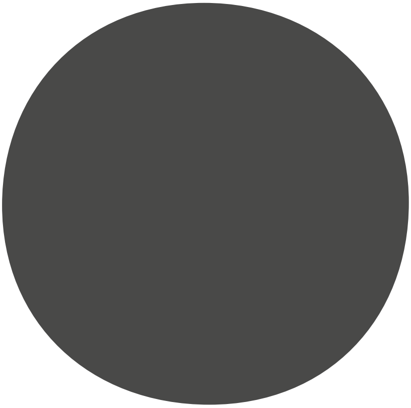
a



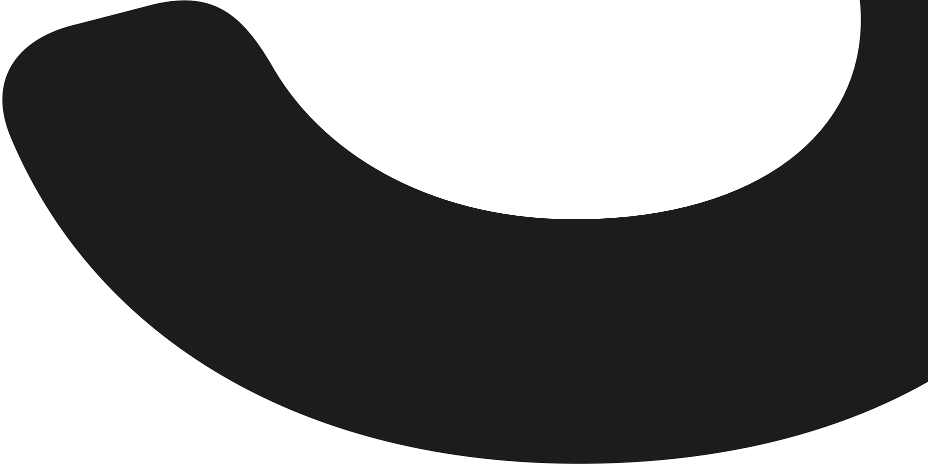
a

K





Flavorings



T

S

p

h

m

W

A

C

st

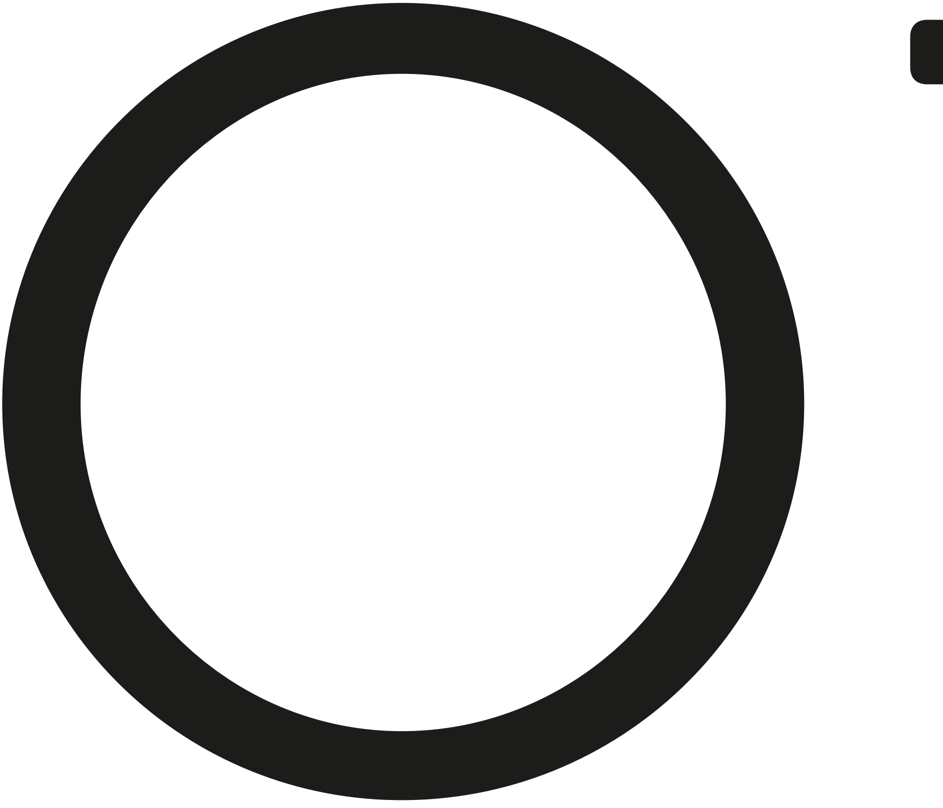
u

B

h

th

C



C

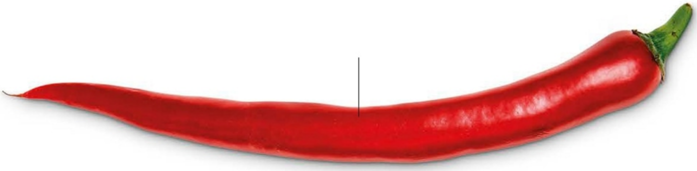
lt

W

a

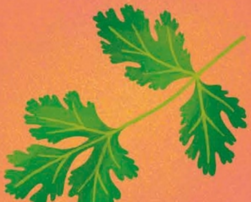
th

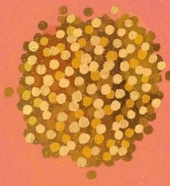
w



Herb or spice?

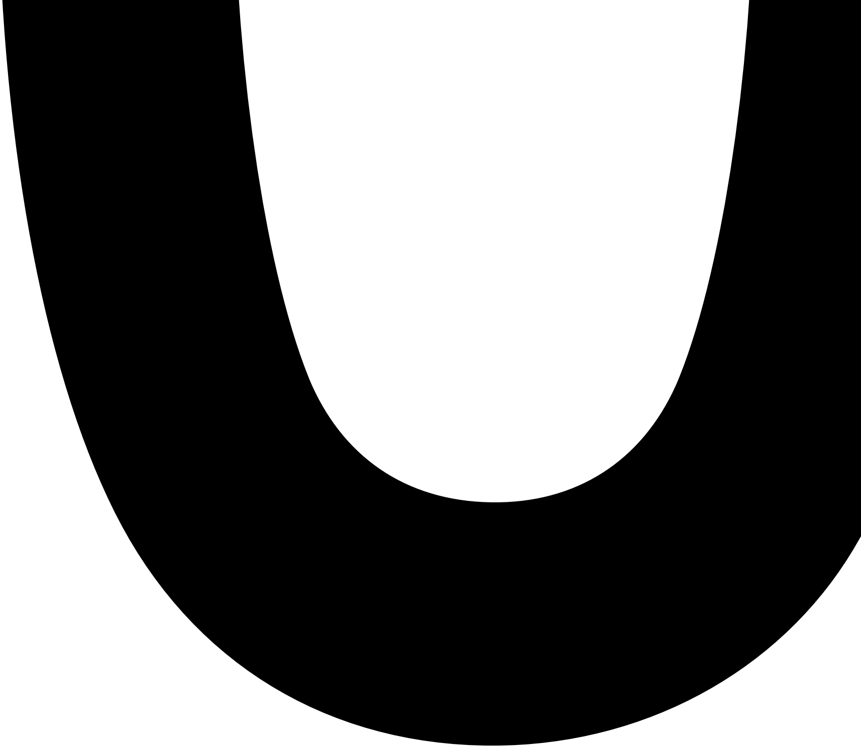
An herb is usually a fresh green leaf, but a spice is often dried before use and comes from any plant part, including seeds, fruits, flowers, and bark. Spices are often ground to a powder or crushed to release their smell and flavor.





[redacted]

V



[redacted]

M

a

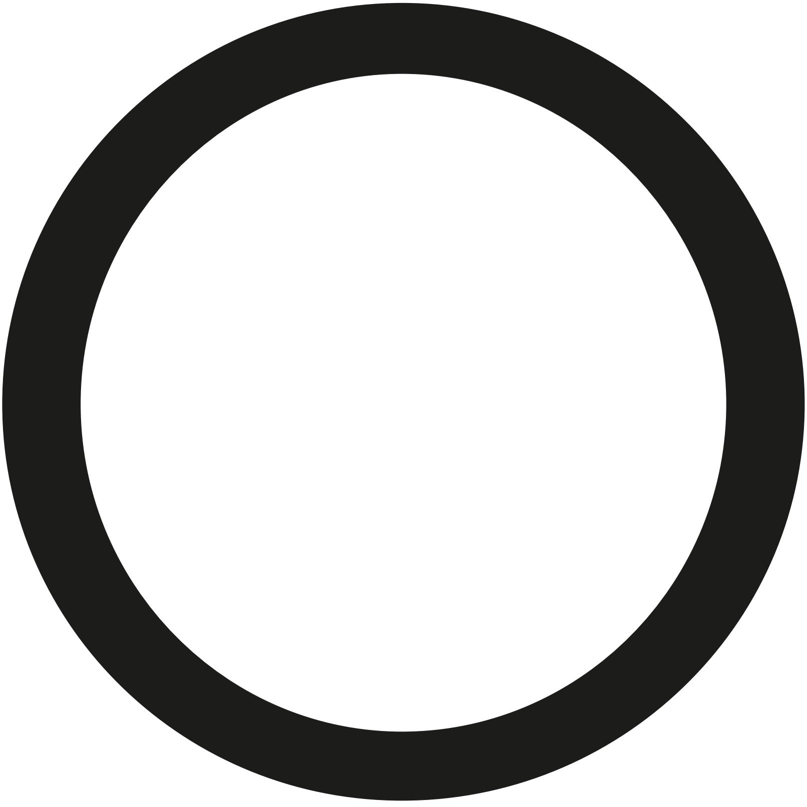
tr

O

fr

C

W

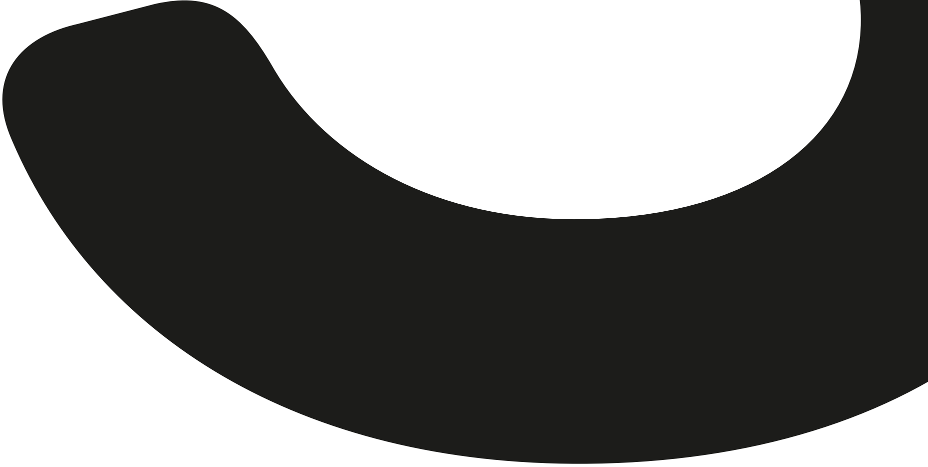


A

C

C

h



M

S

B

C

re

d

V

g

se

t

m

H

(

S

(

T

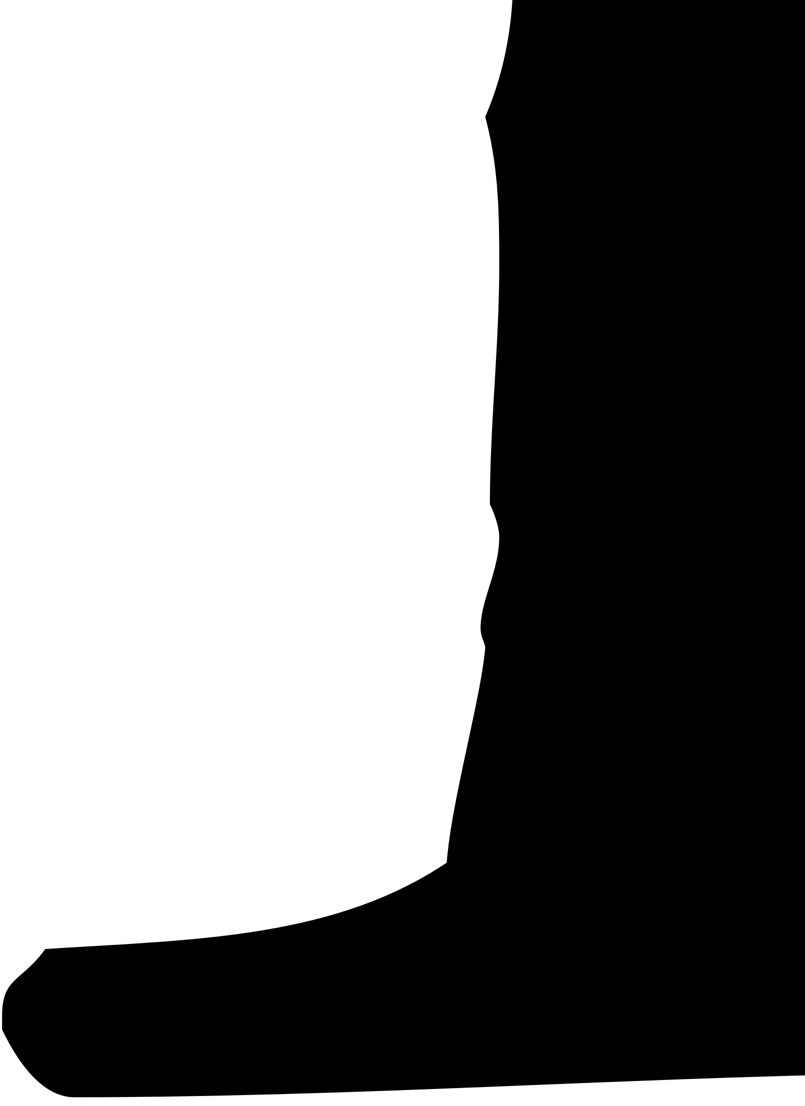
is

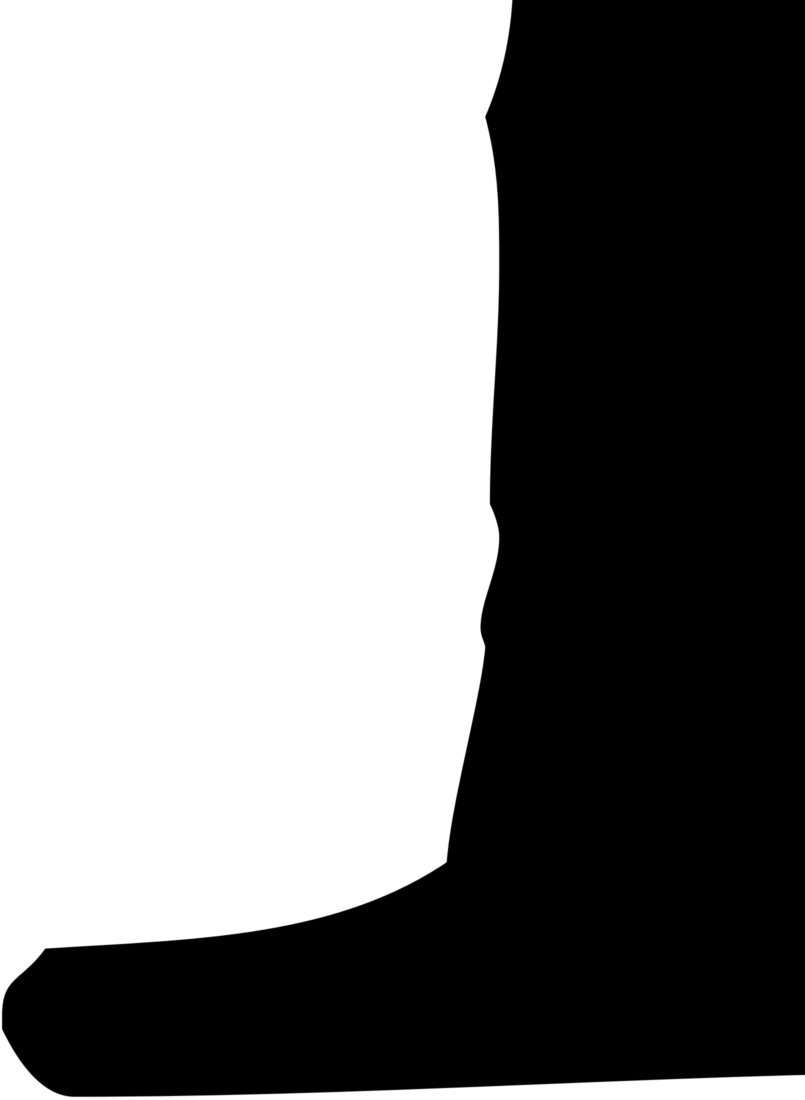
re

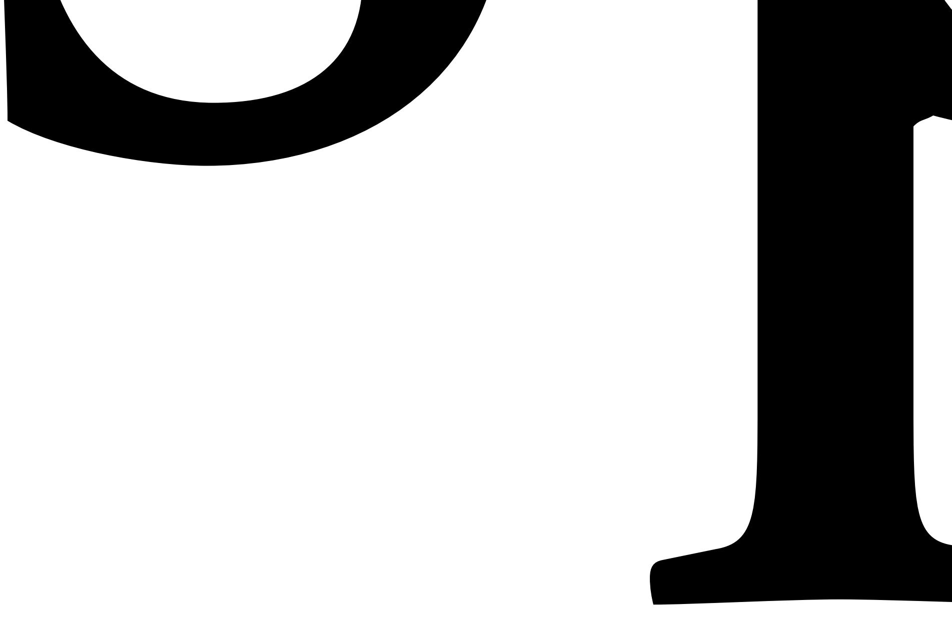
B

ch

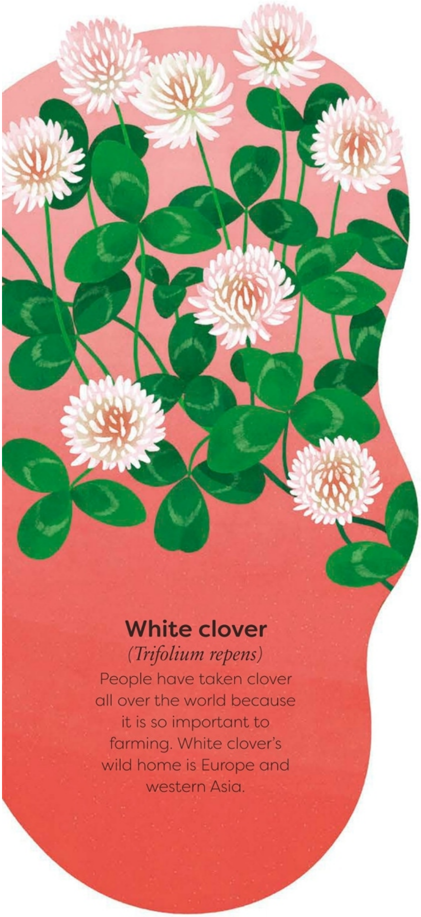
t







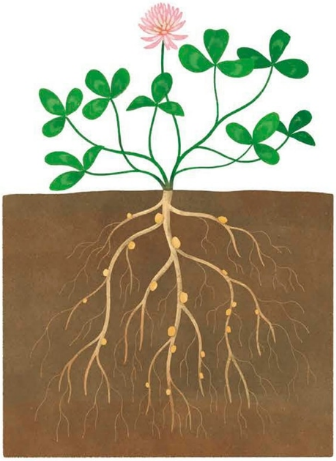
Clover



White clover

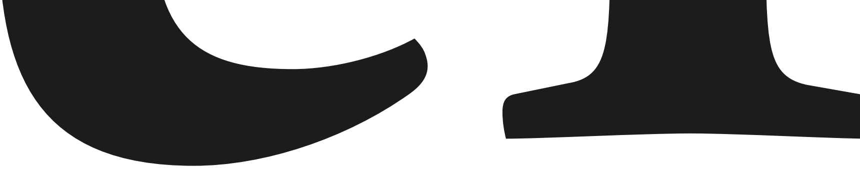
(Trifolium repens)

People have taken clover all over the world because it is so important to farming. White clover's wild home is Europe and western Asia.



Fixing nitrogen

Clover roots are covered in tiny lumps that are full of bacteria. These tiny organisms absorb nitrogen and convert it to a form that helps the clover grow, in a process called nitrogen fixing. When the clover dies, its nitrogen goes into the soil.



C

lu

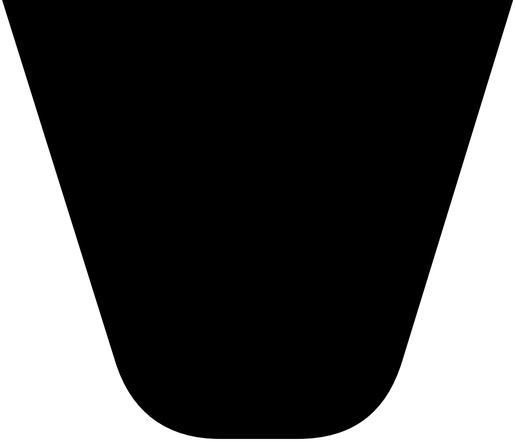
ti

C

C

n

d



P

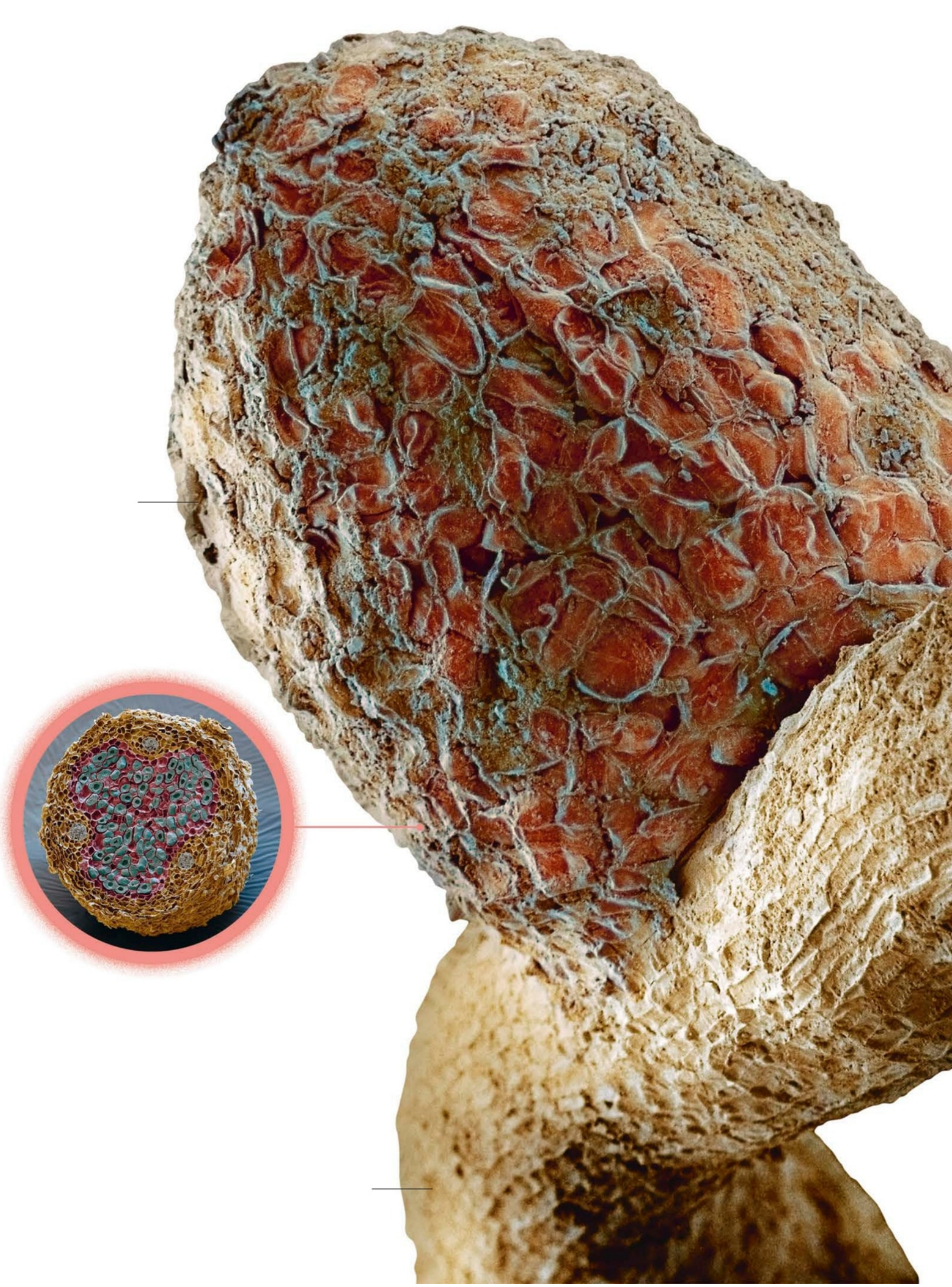
a

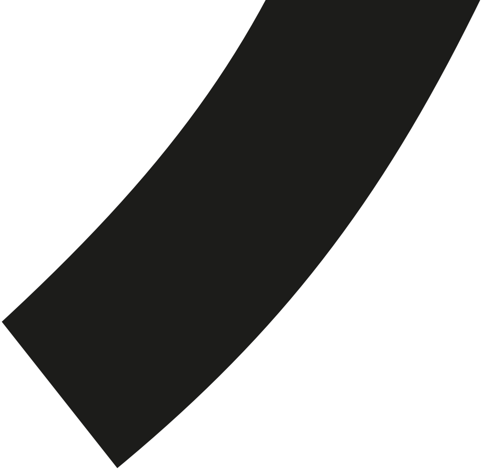
it

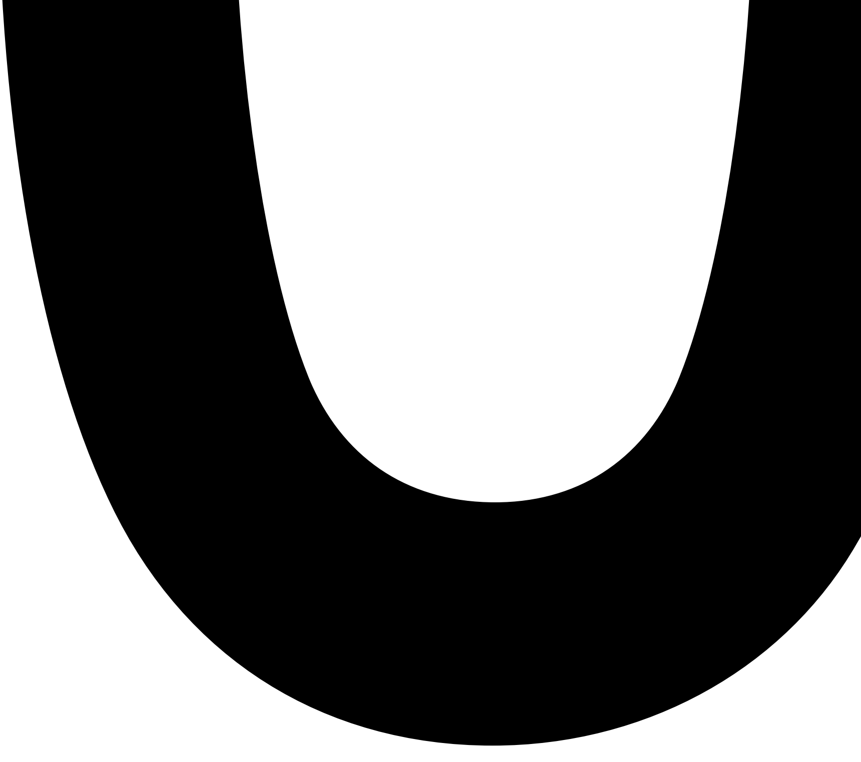
f

w

W







V

L

th

C

th

a

th

Th

a

(2

N

th

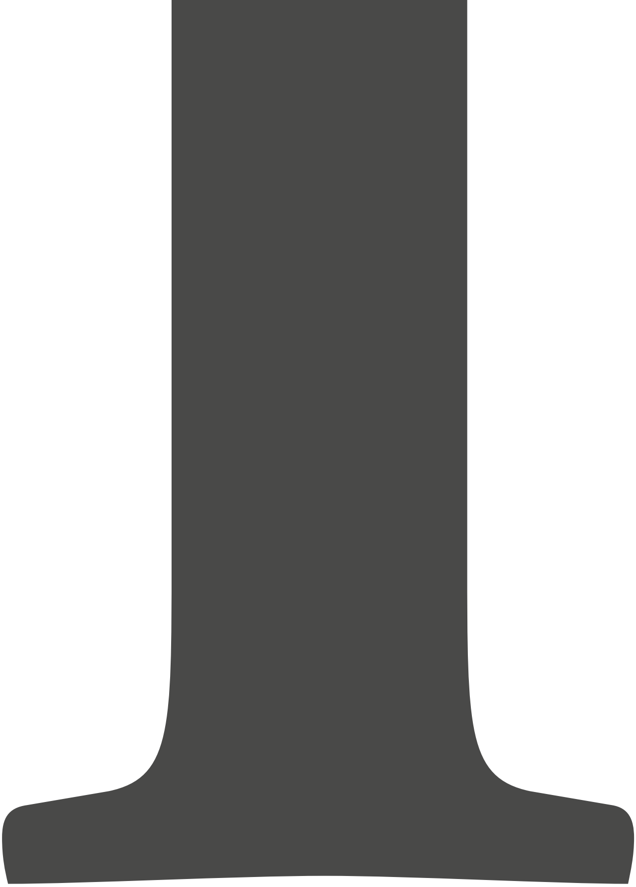
A

le

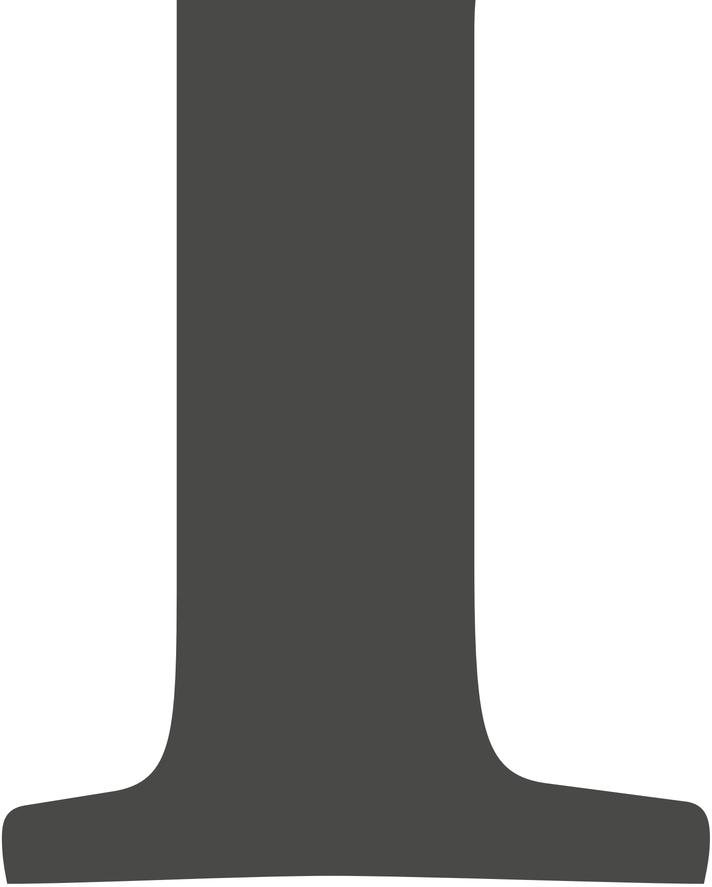
b

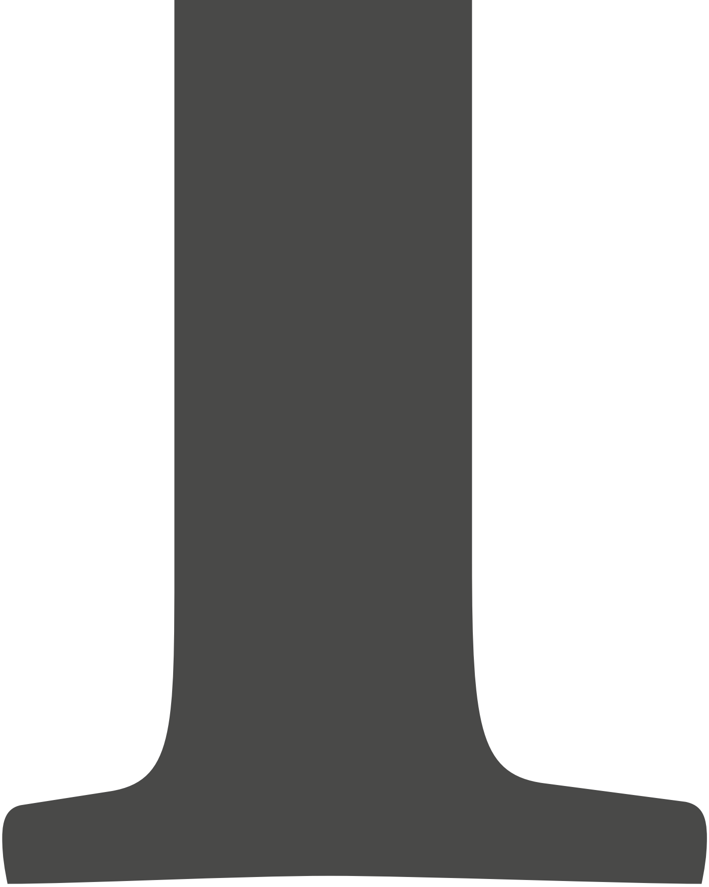
W

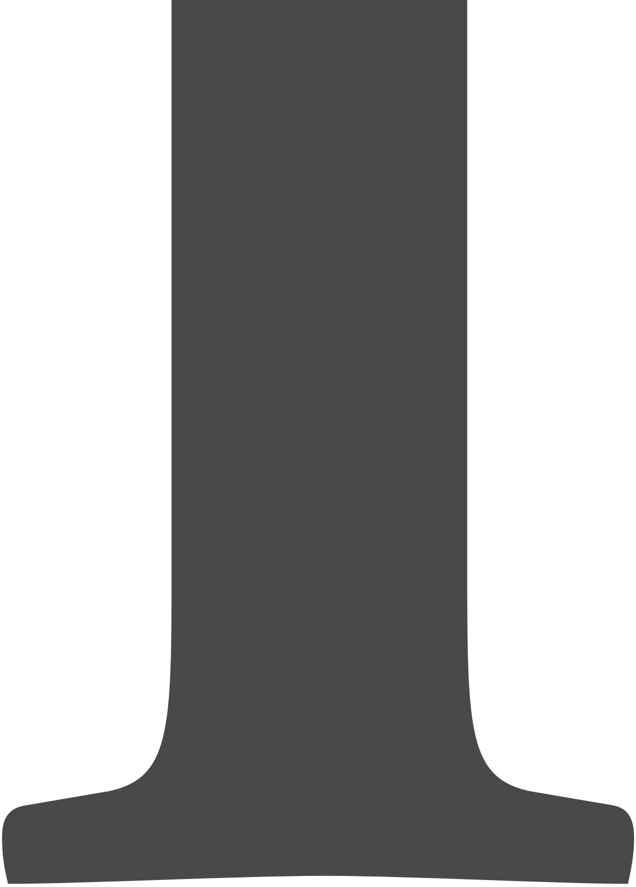
is



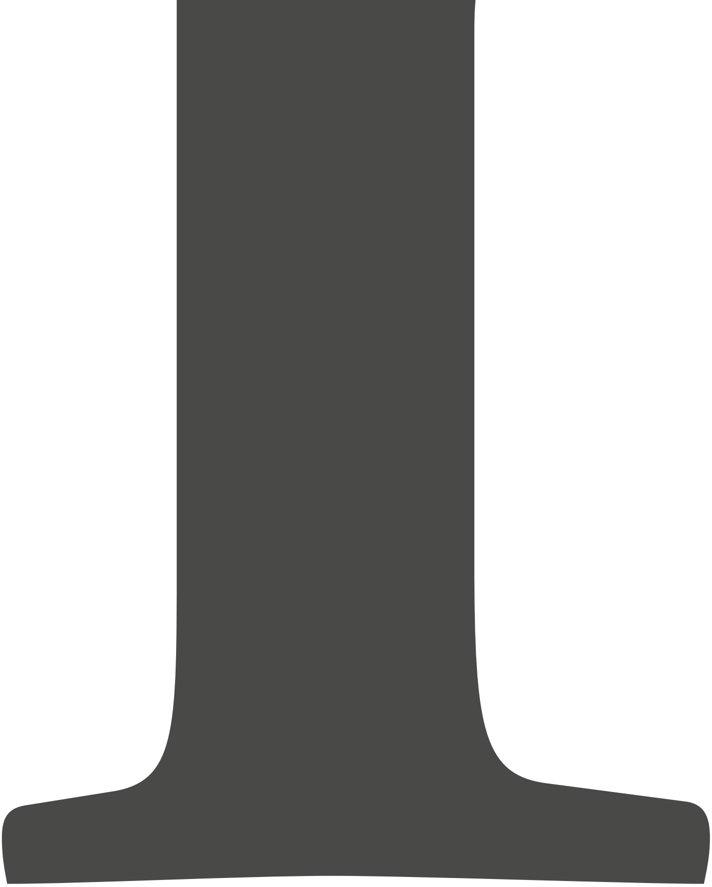
V

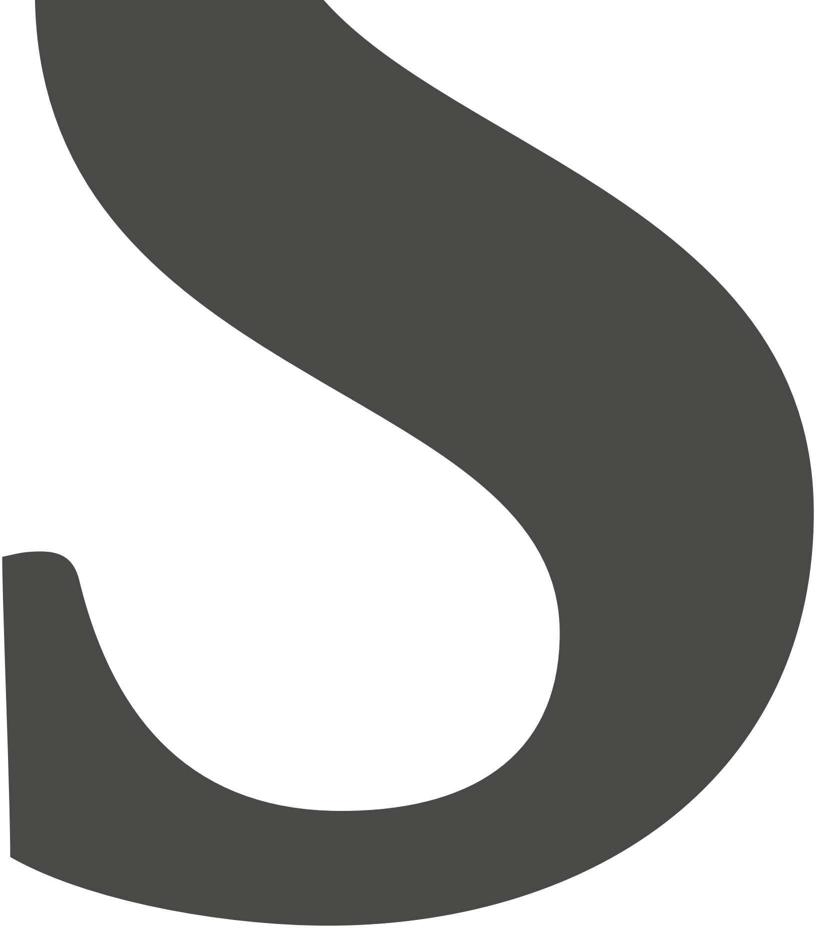


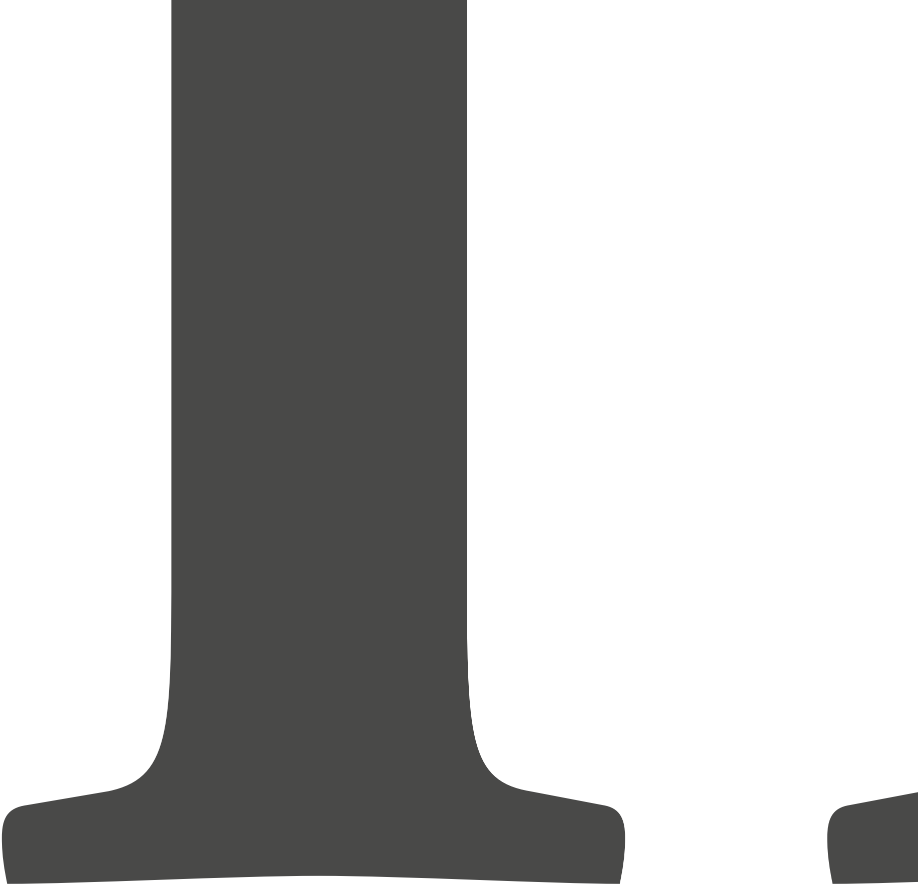




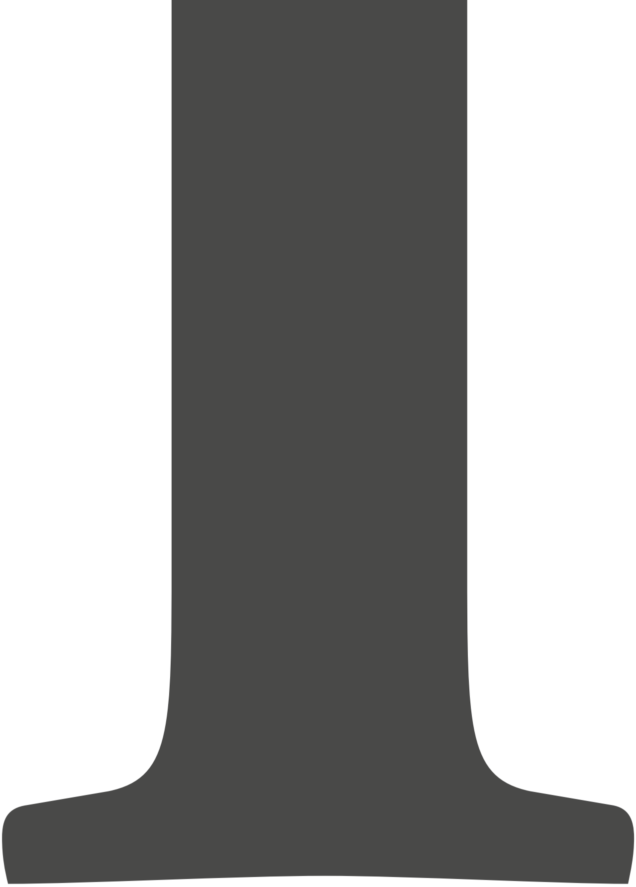
V

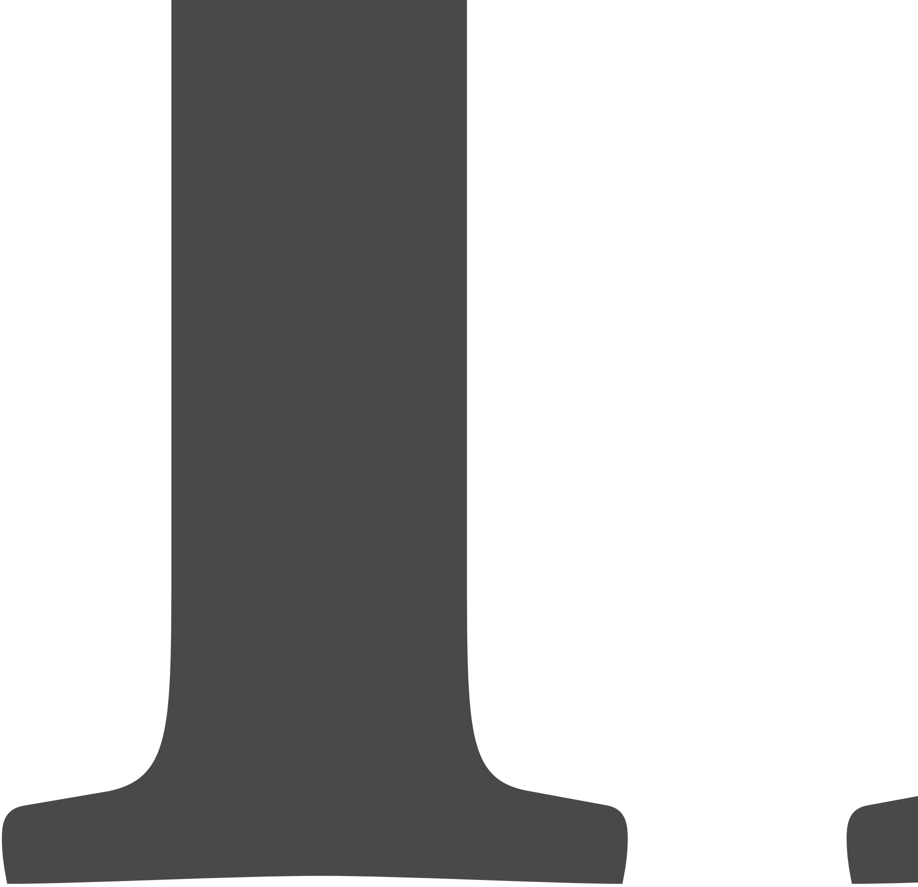


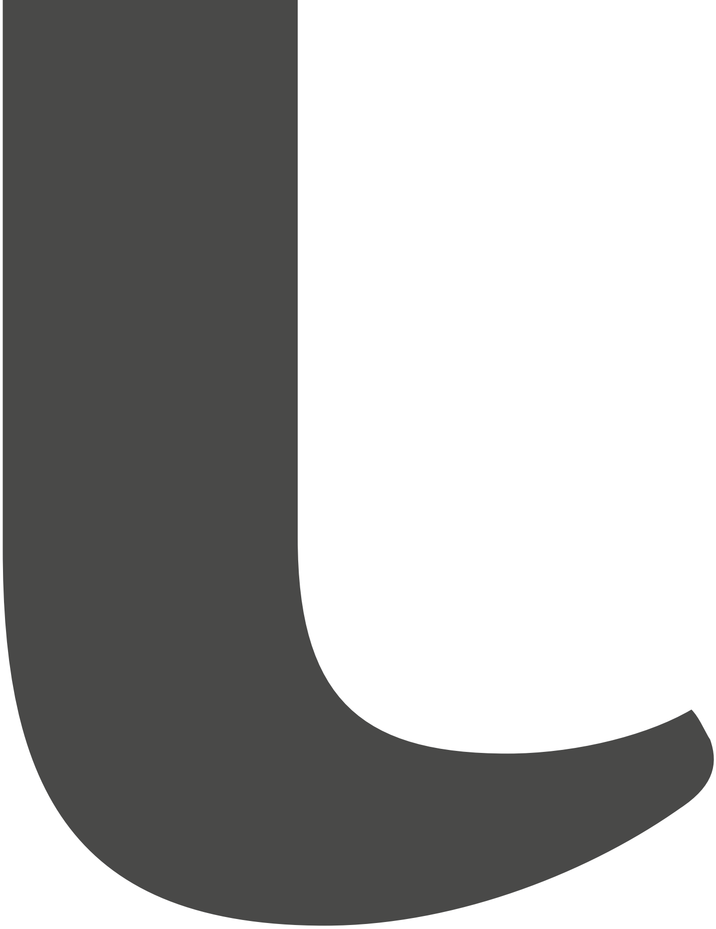


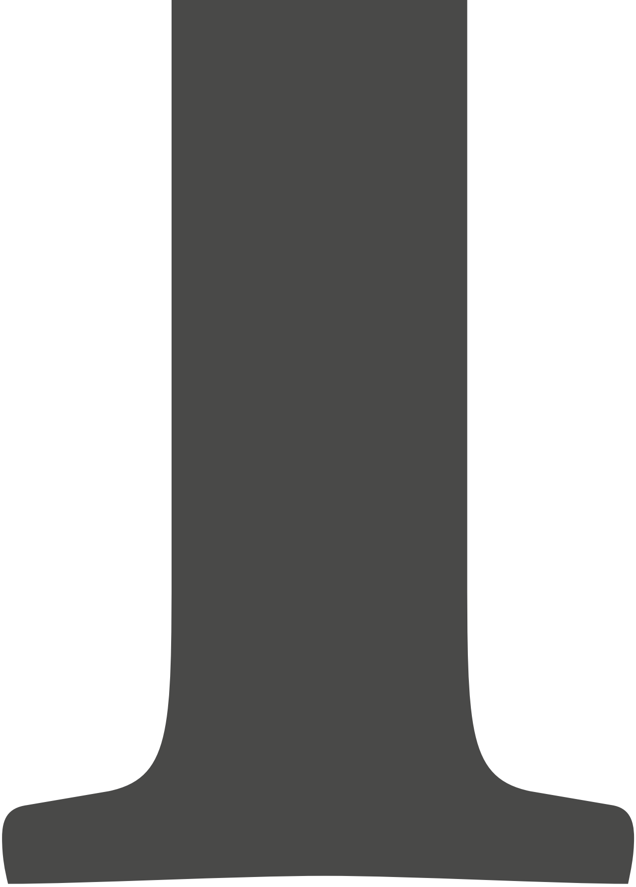


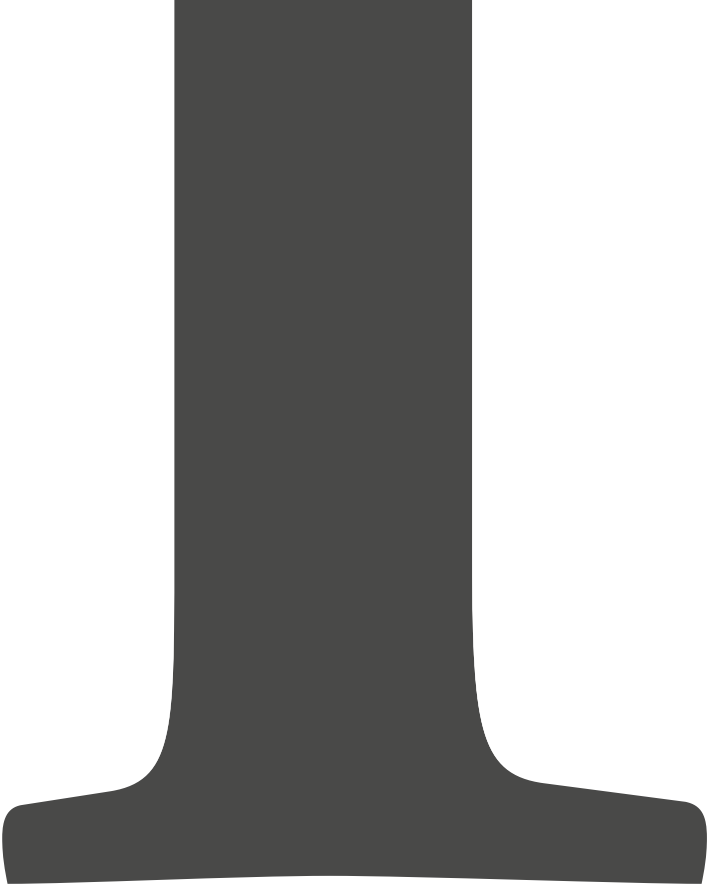
V

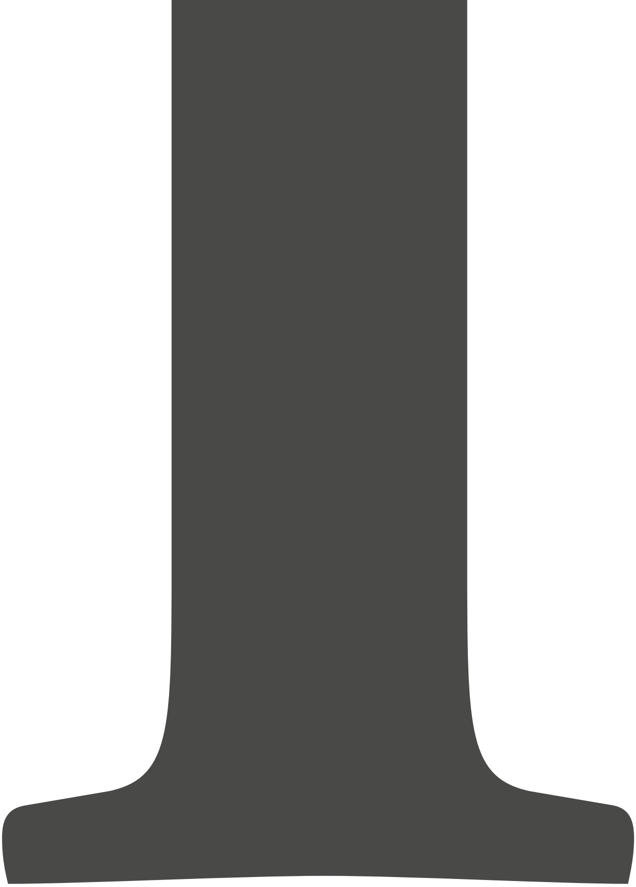


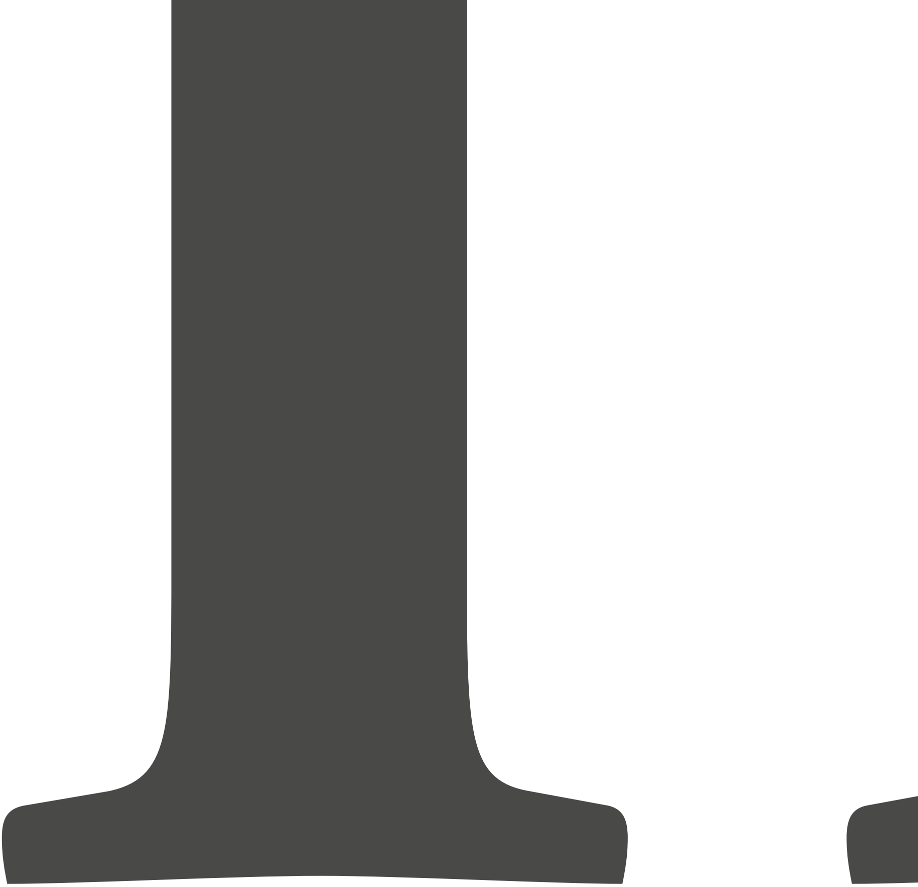


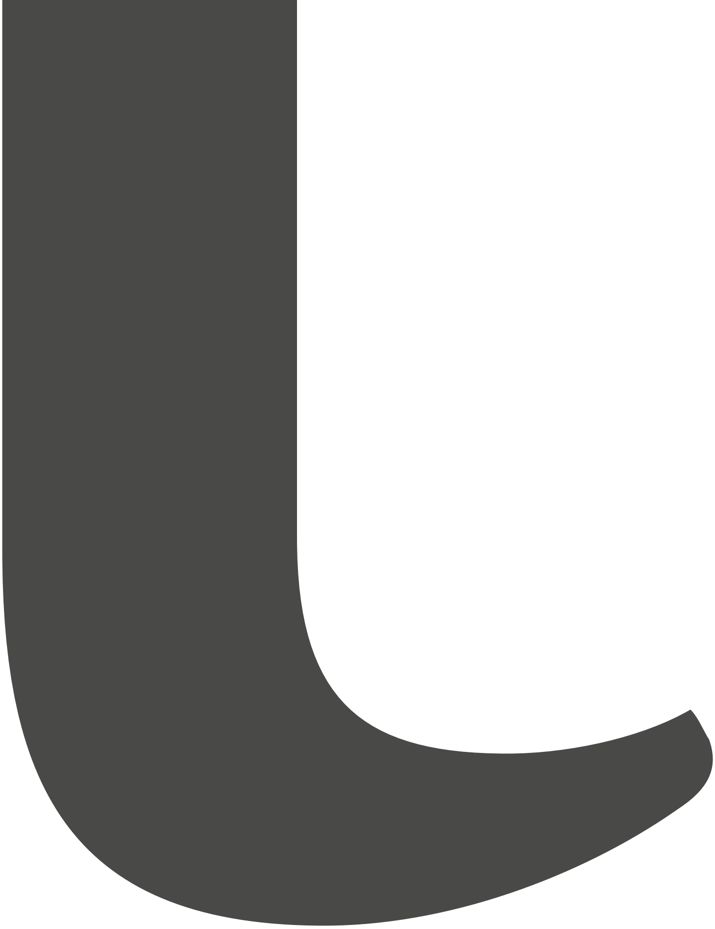


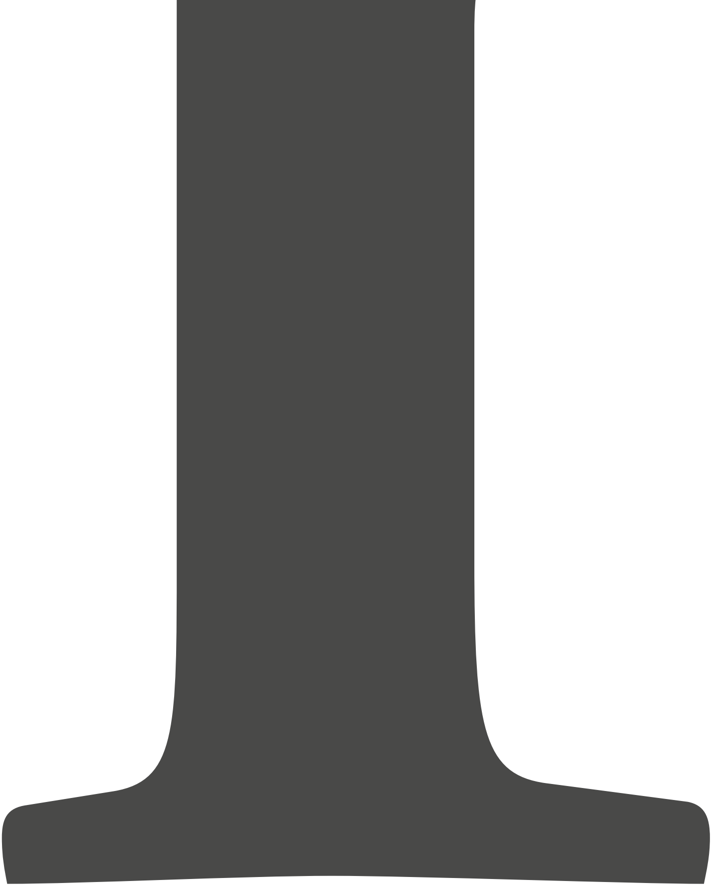


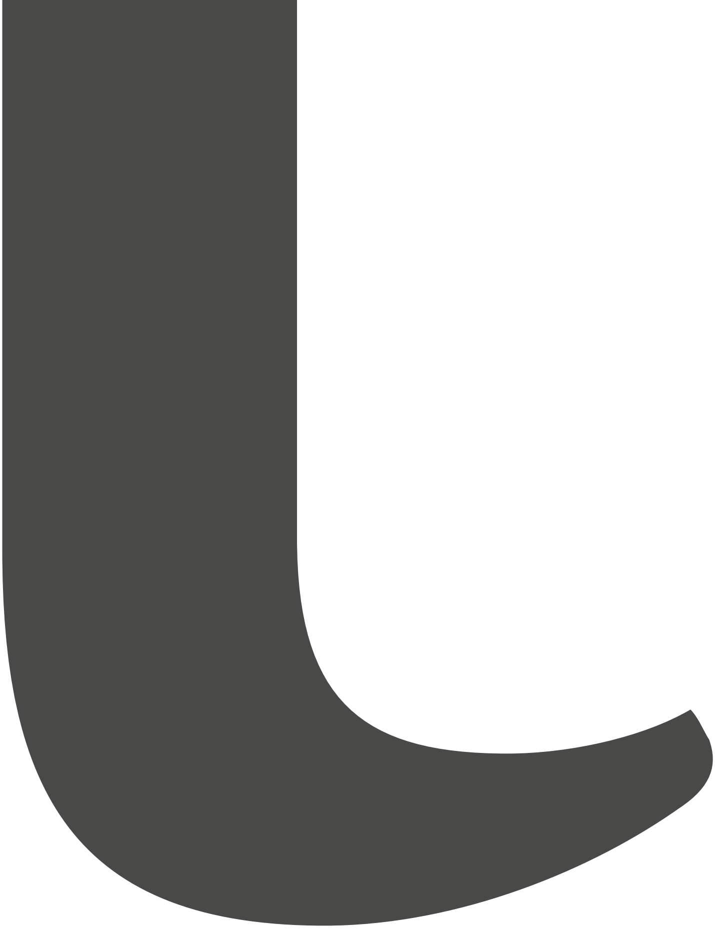


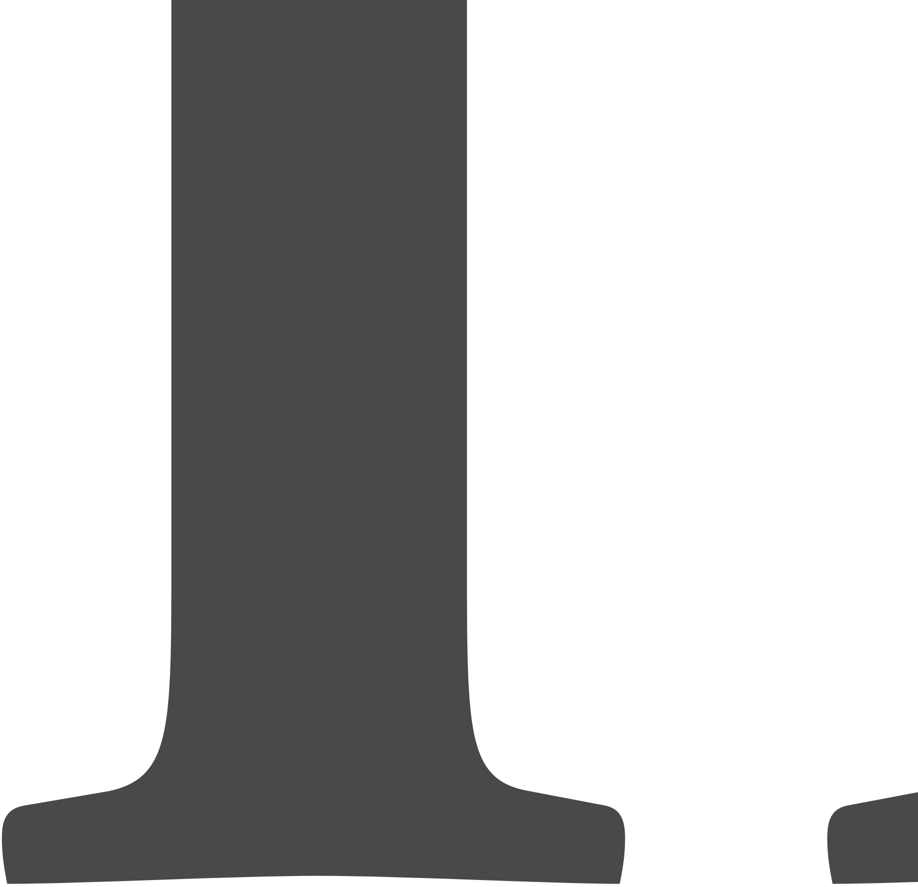




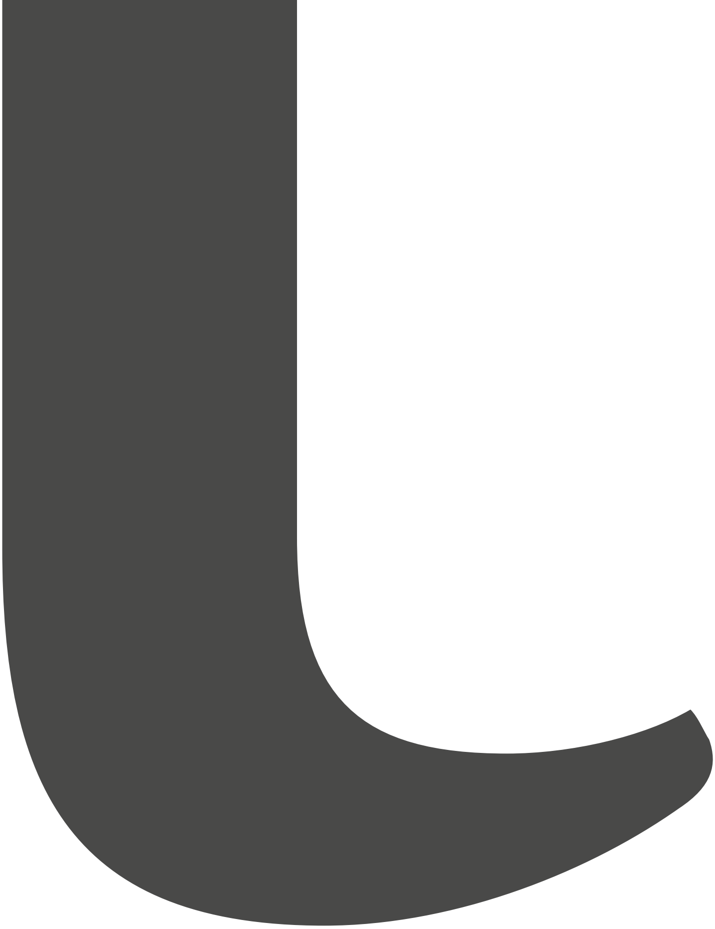


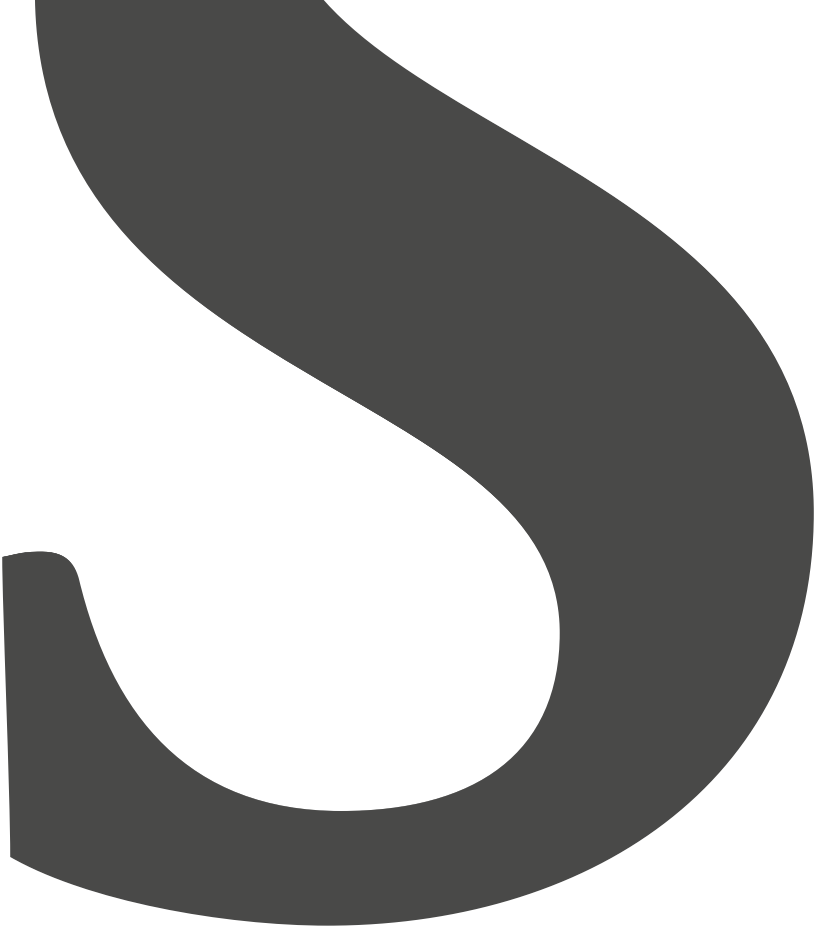


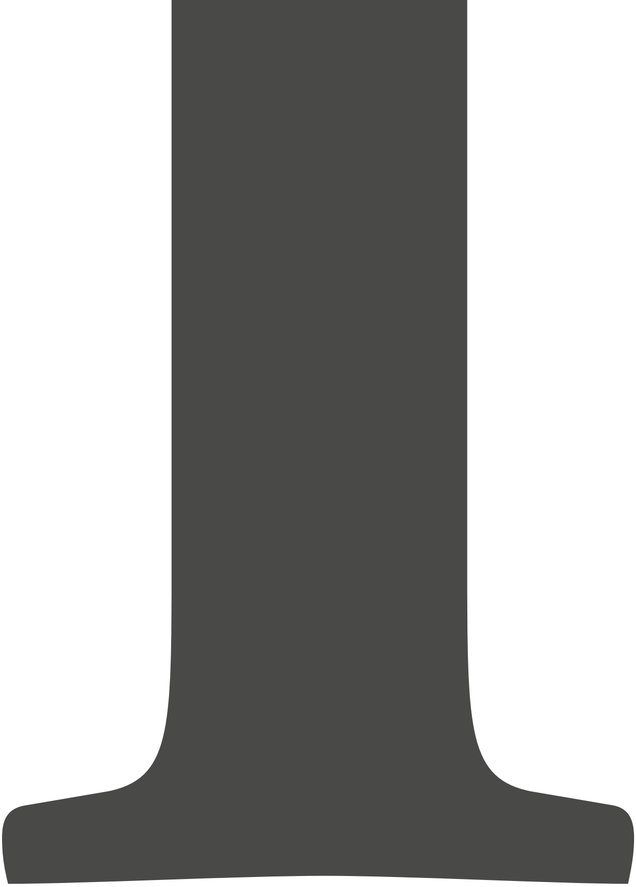




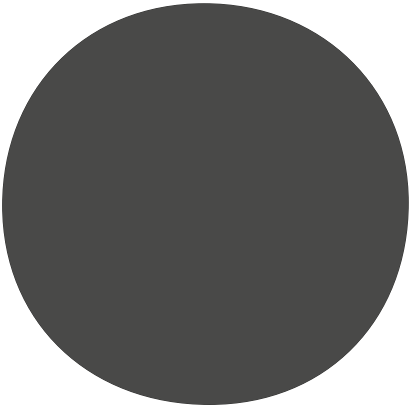
a

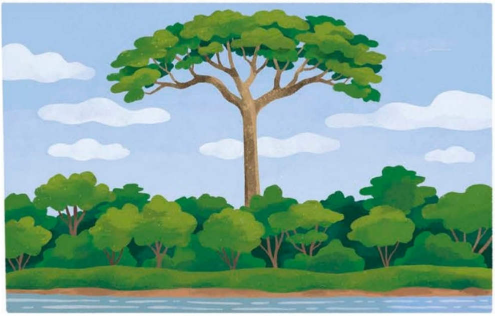






V





Top of the forest

Kapoks emerge above the rain forest canopy. Their leaves are not crowded by other trees, so they are bathed in sunlight and can carry out as much photosynthesis as possible. Forest giants that grow in this way are known as emergent trees.

K

T

th

a

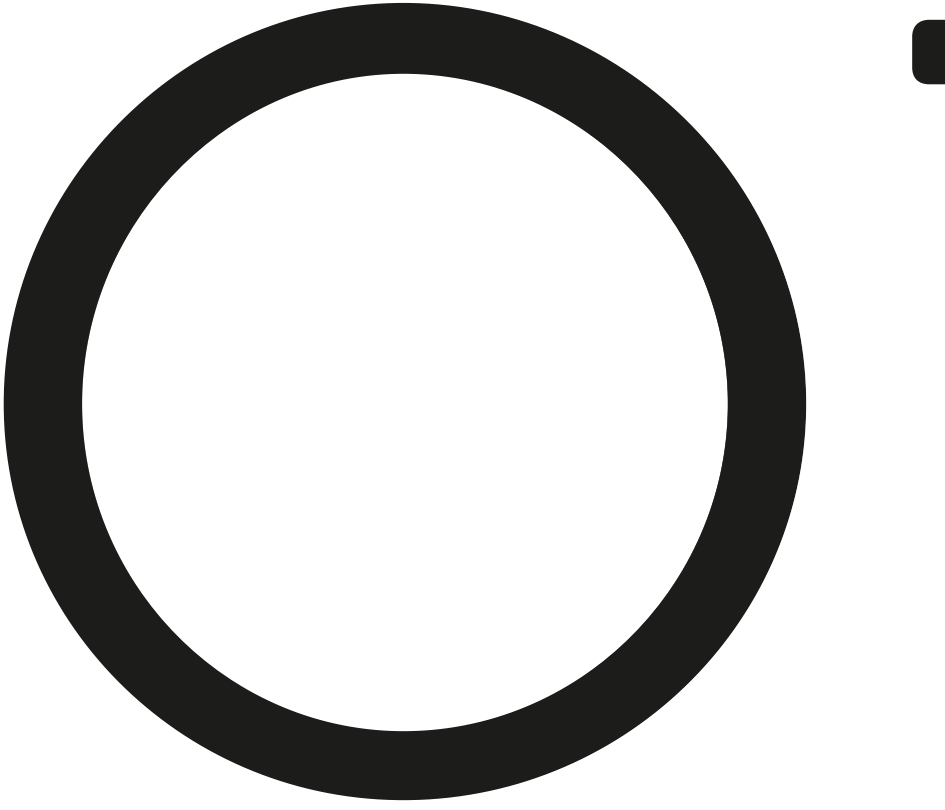
g

e

K

W

g



C

C

D

b

sh

a

ro

T

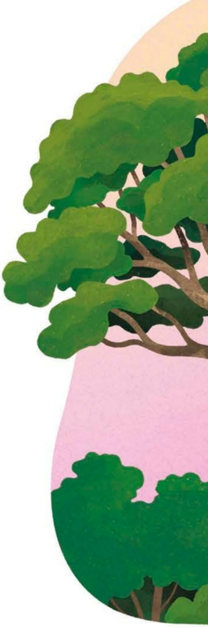
a

re

fl

a

Kapok

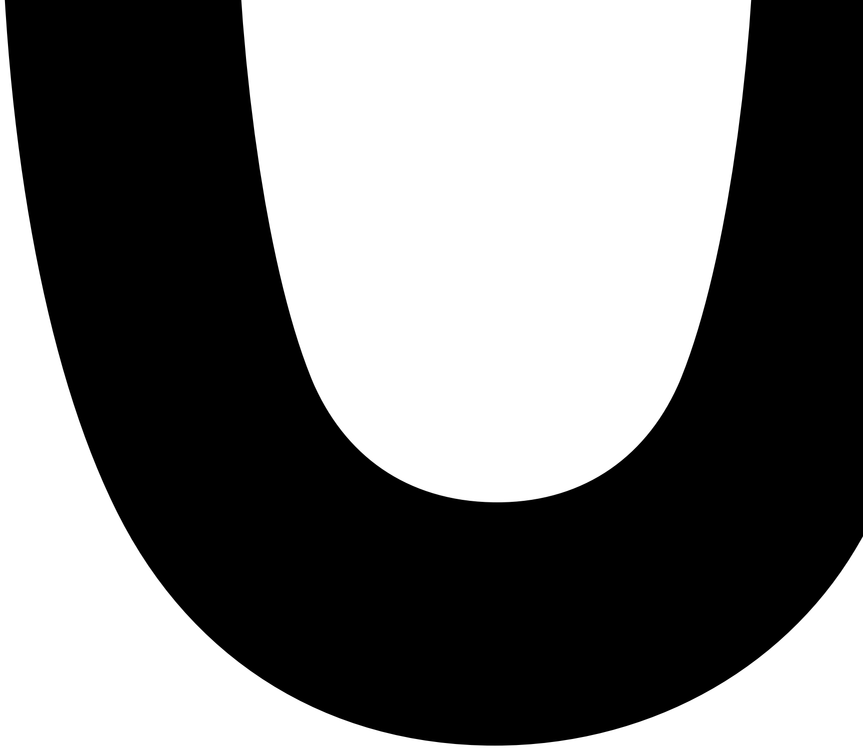


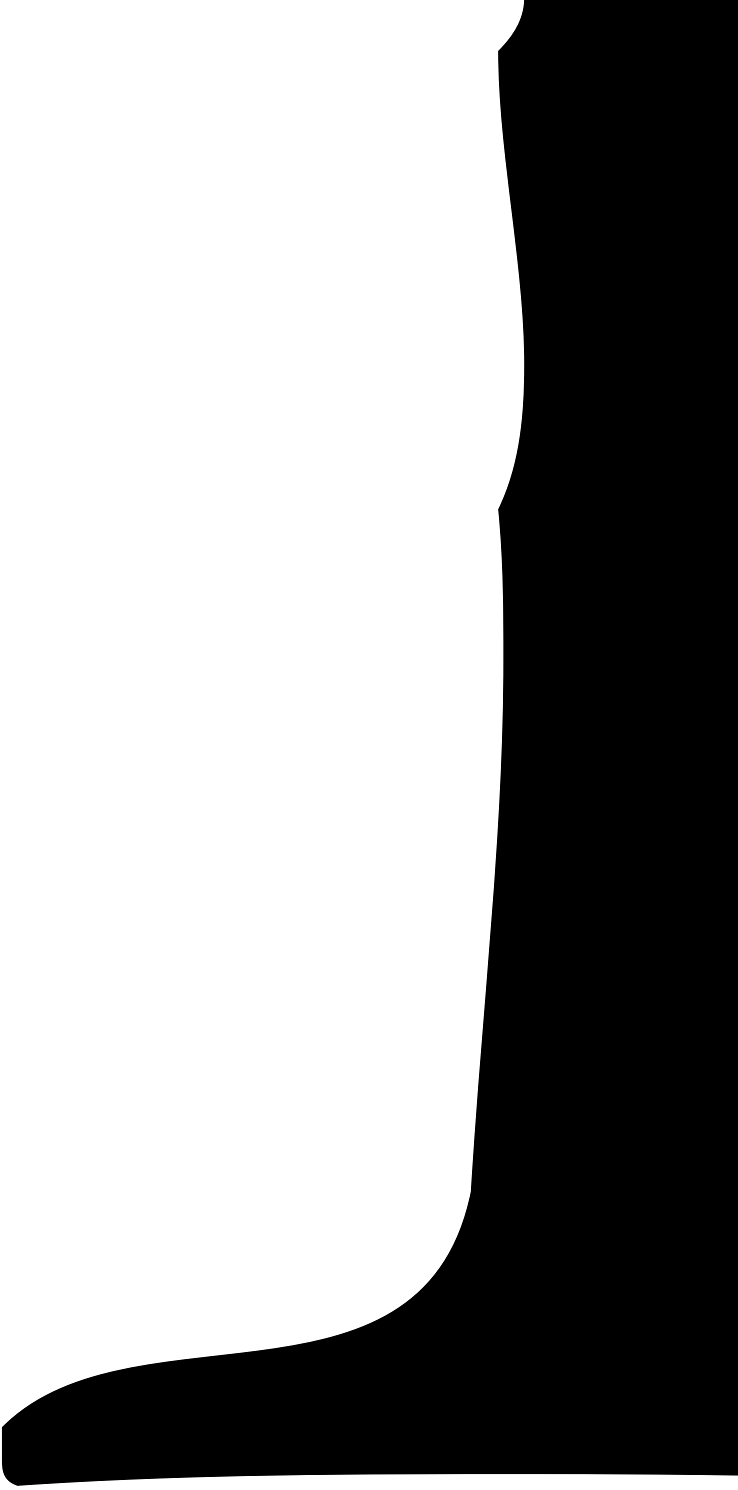
Kap

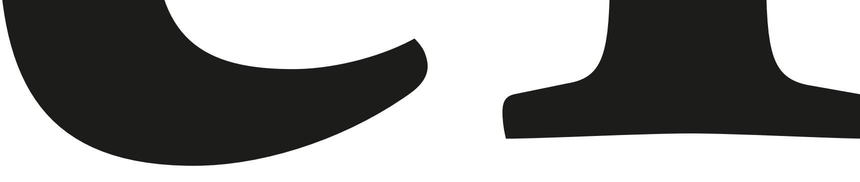
(Ceiba pe

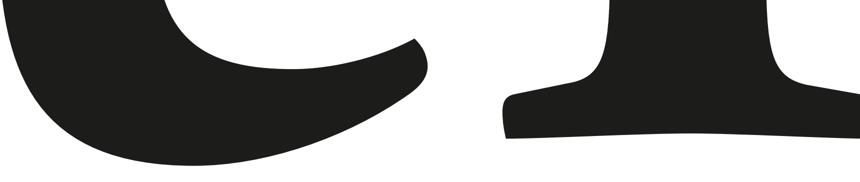
The kapok is
tallest trees in
South Americ
naturally spre
Africa. High u
and branc
sharp s

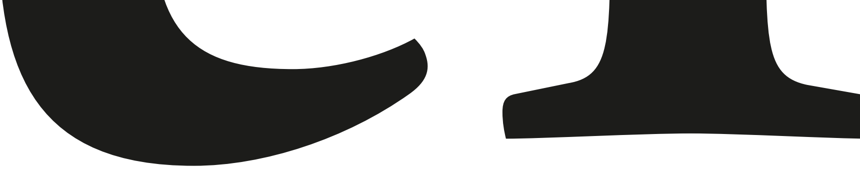
[redacted]

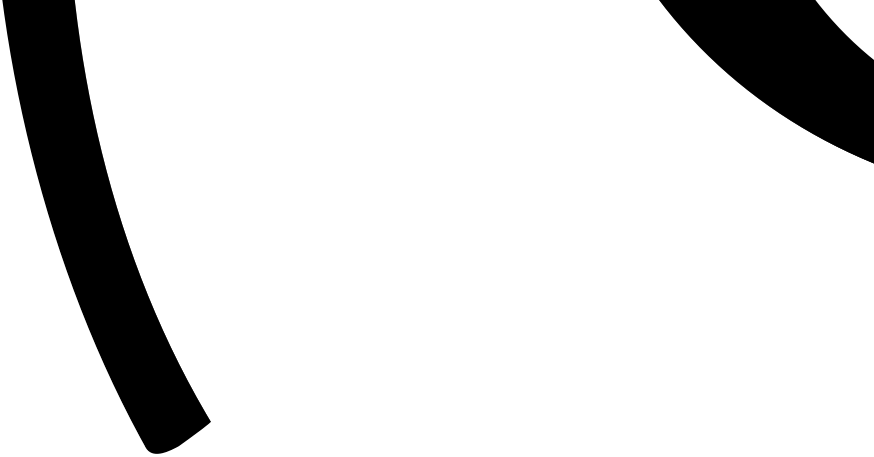












T

t

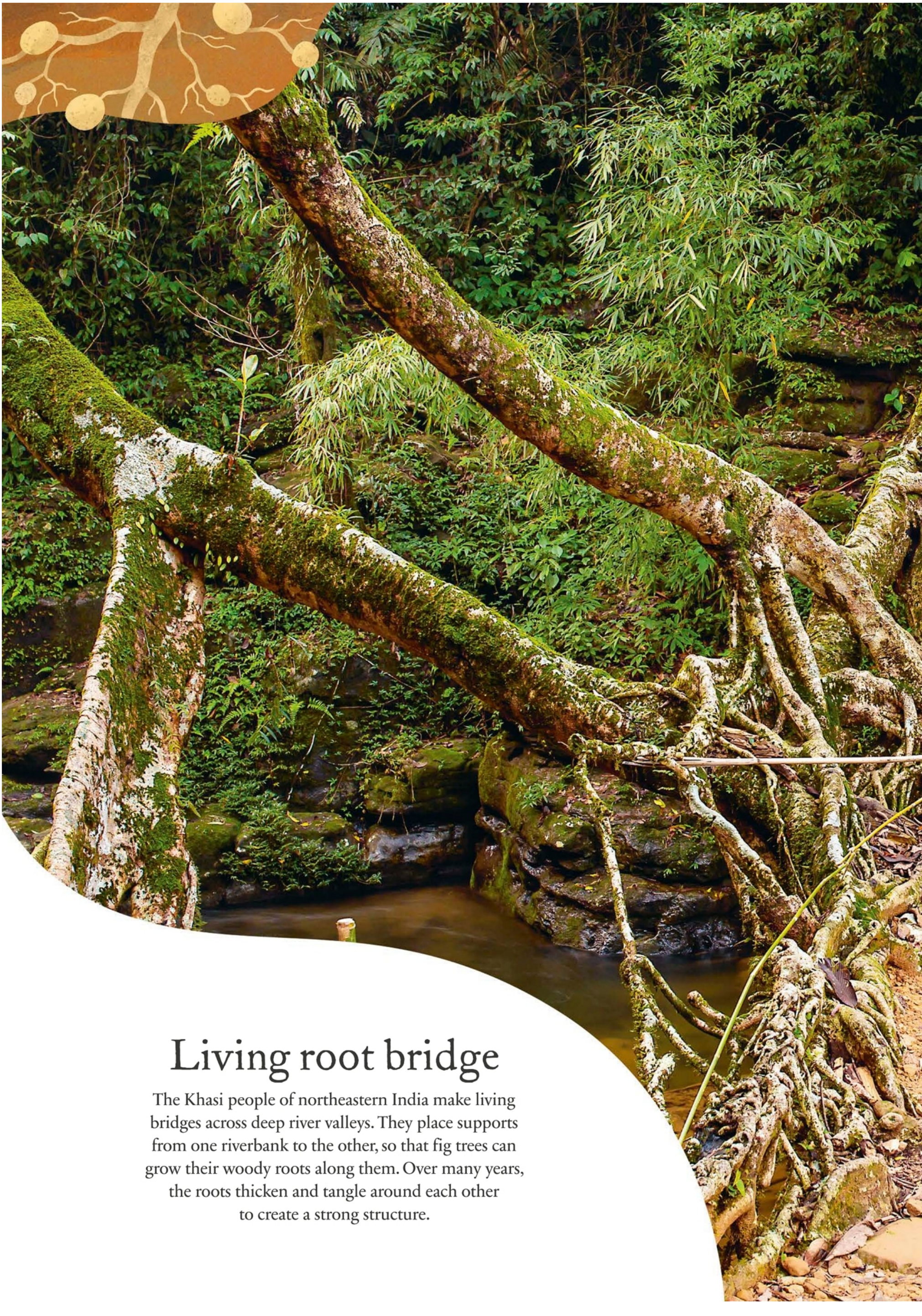
S

n

A

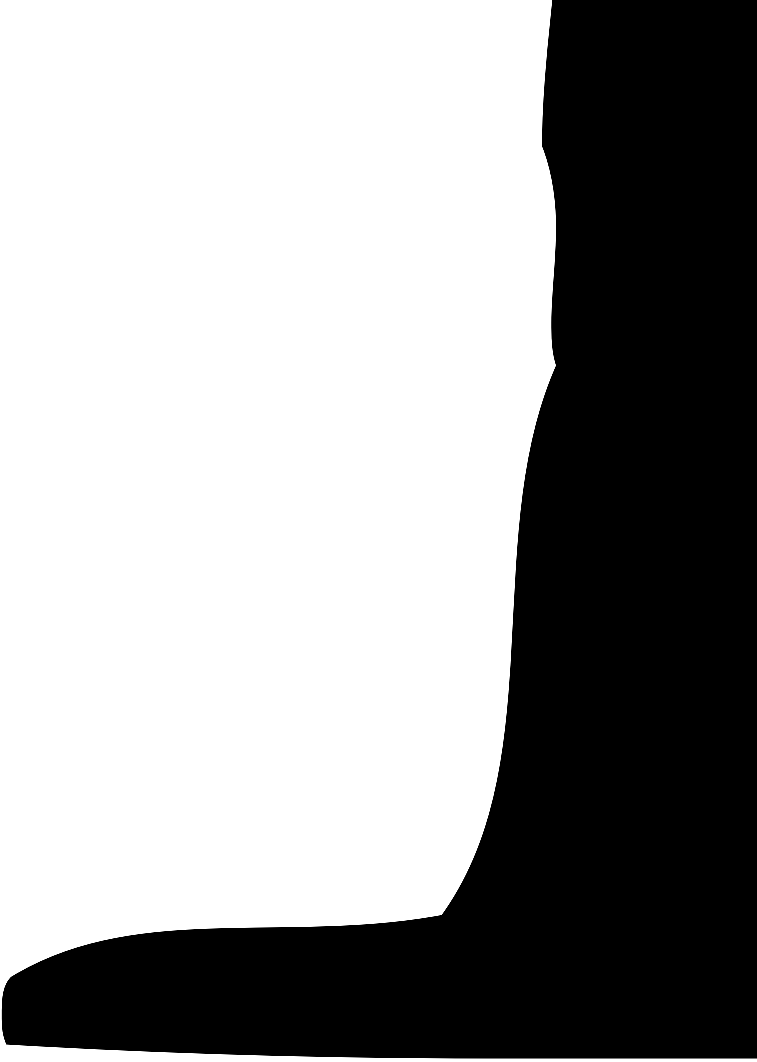
a

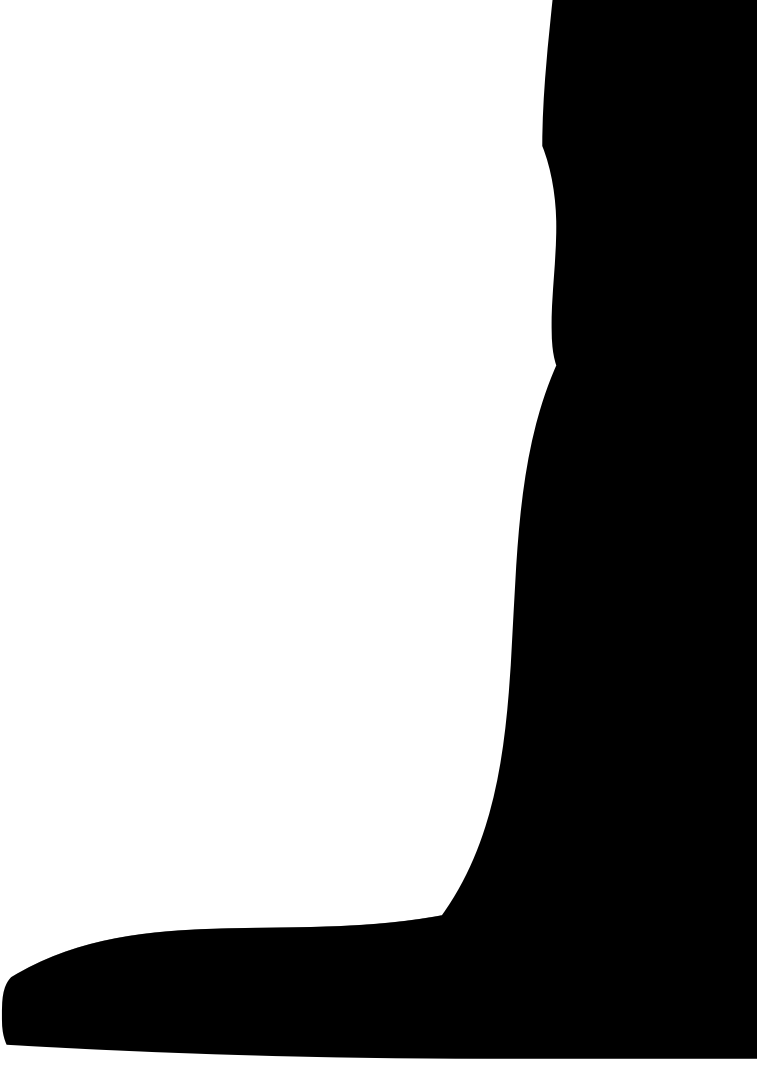
sh



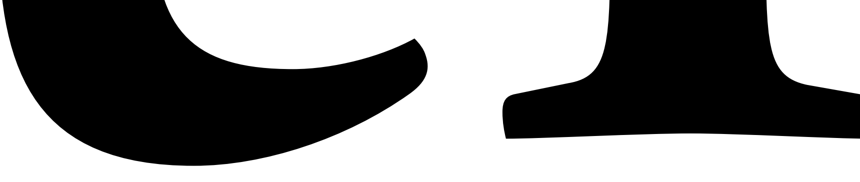
Living root bridge

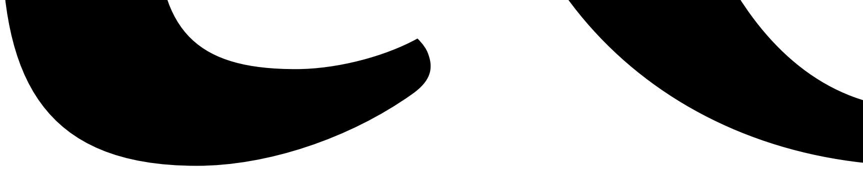
The Khasi people of northeastern India make living bridges across deep river valleys. They place supports from one riverbank to the other, so that fig trees can grow their woody roots along them. Over many years, the roots thicken and tangle around each other to create a strong structure.





g





T

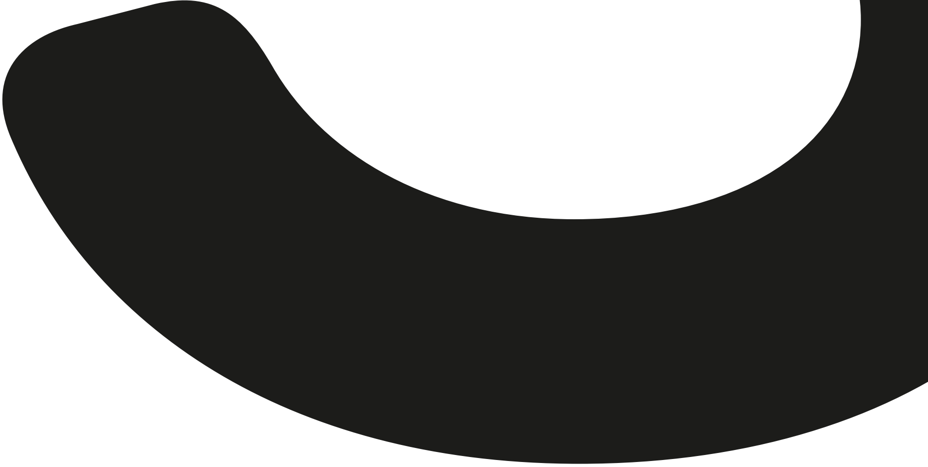
st

th

p

o

C



S

a

th

e

th

t

E

tv

a

R

b

a

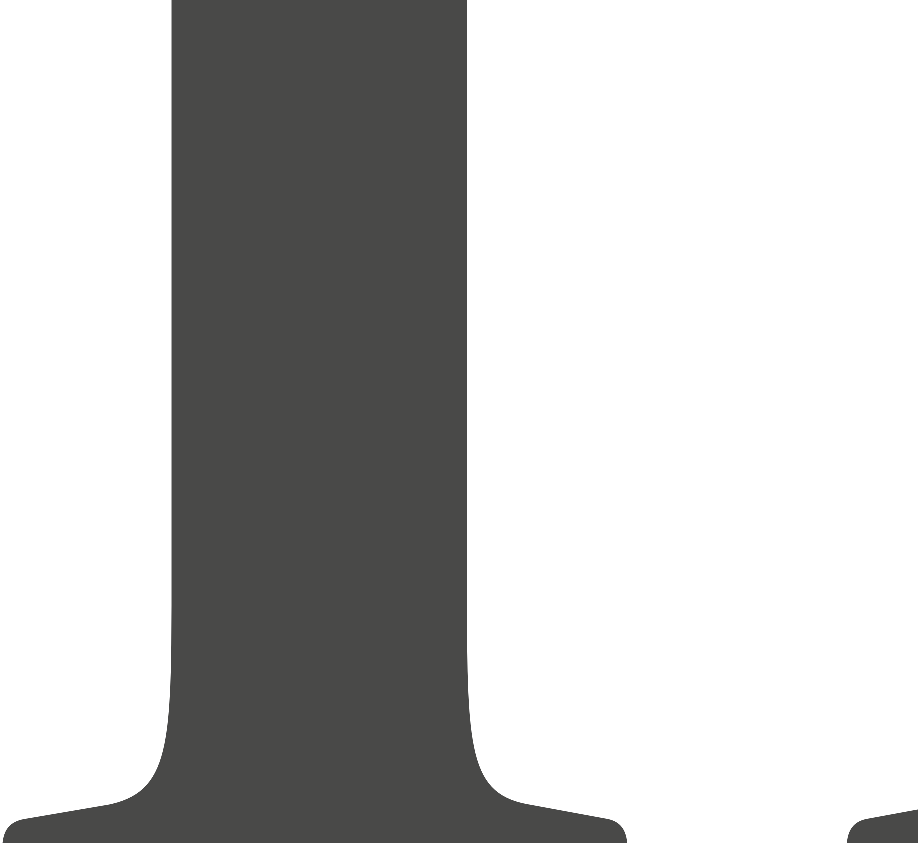
T

sh

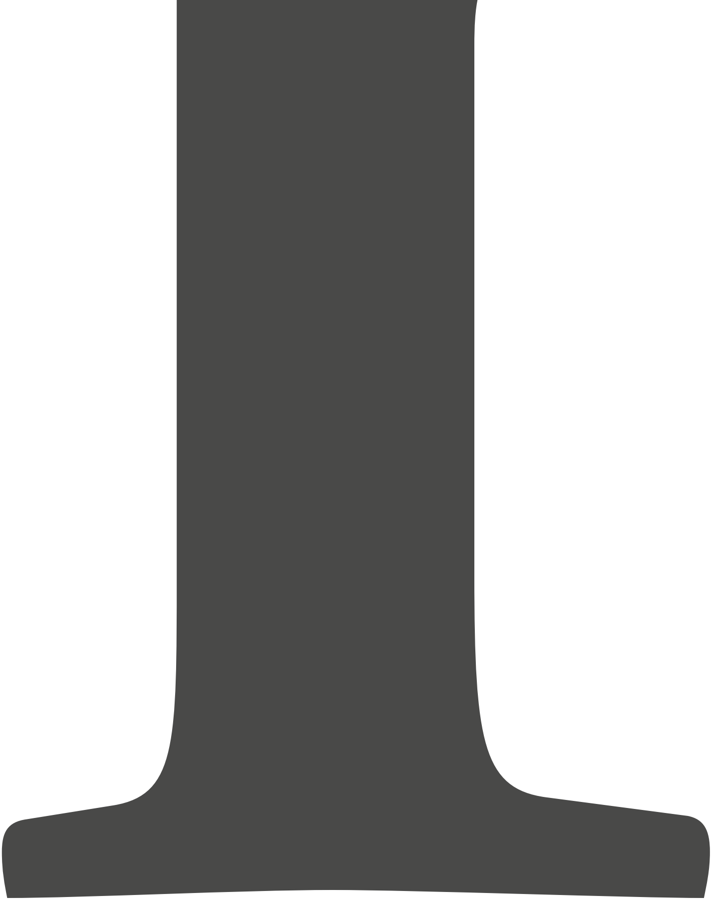
sp

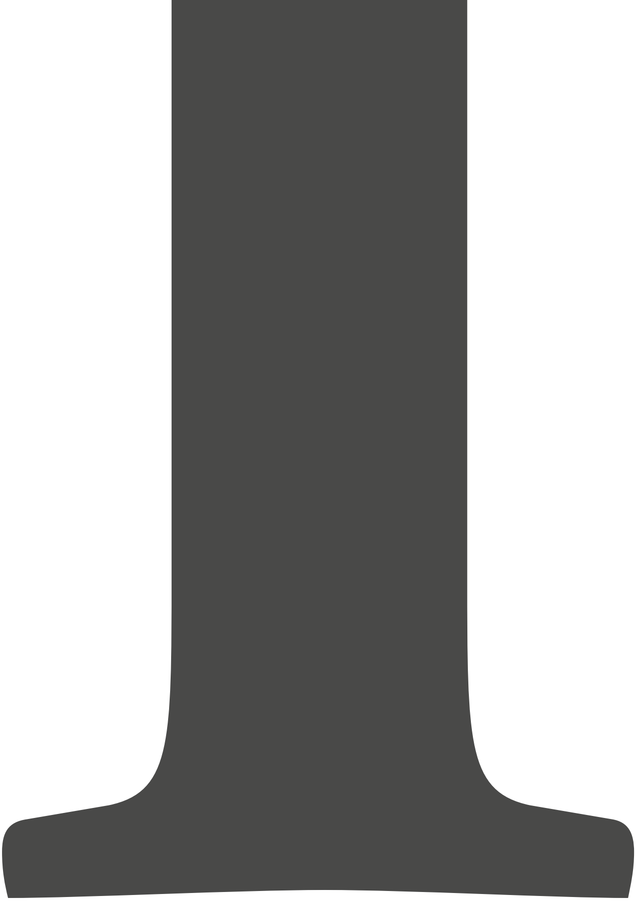
b

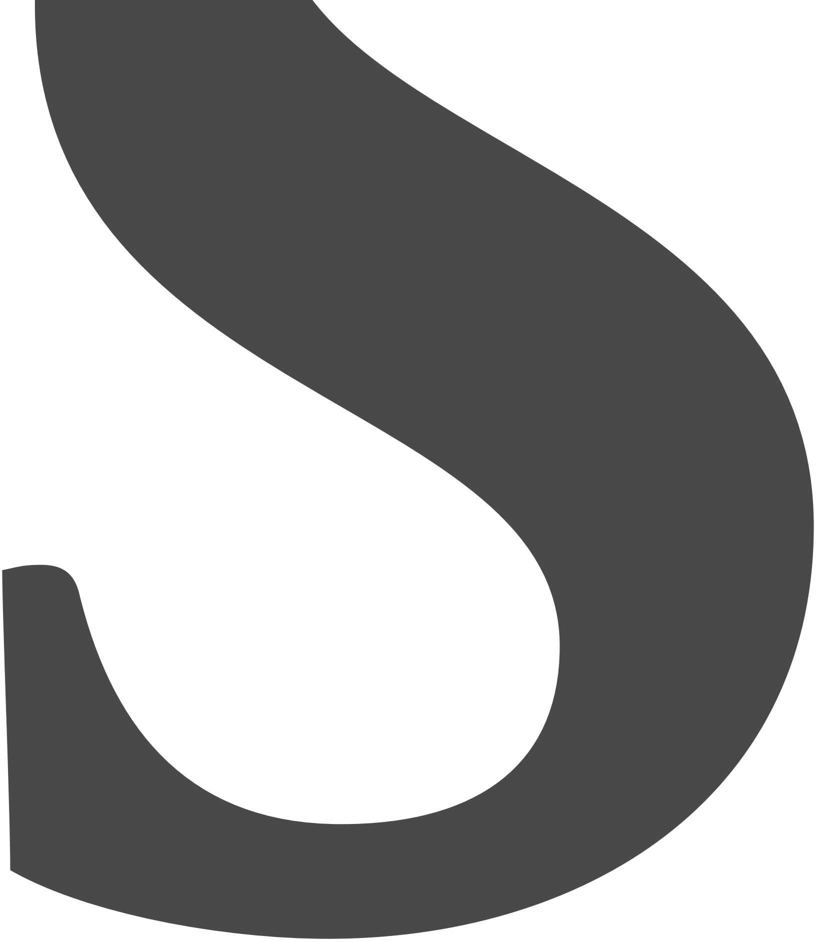
C



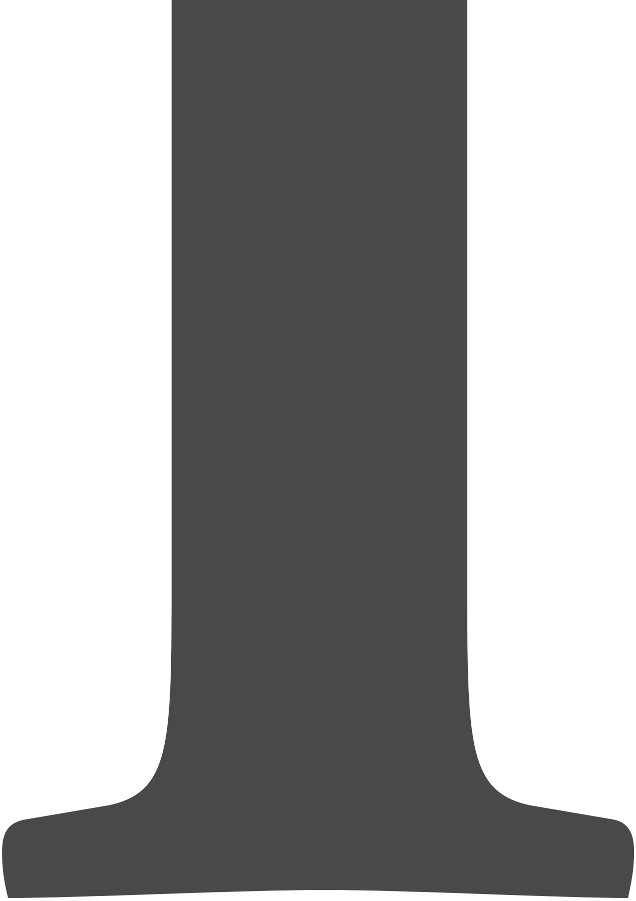
V

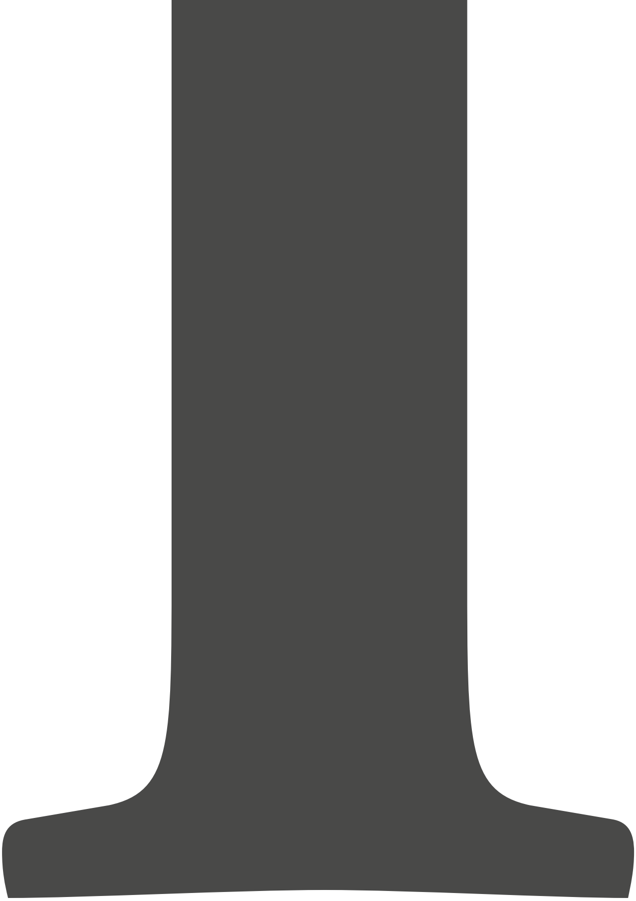


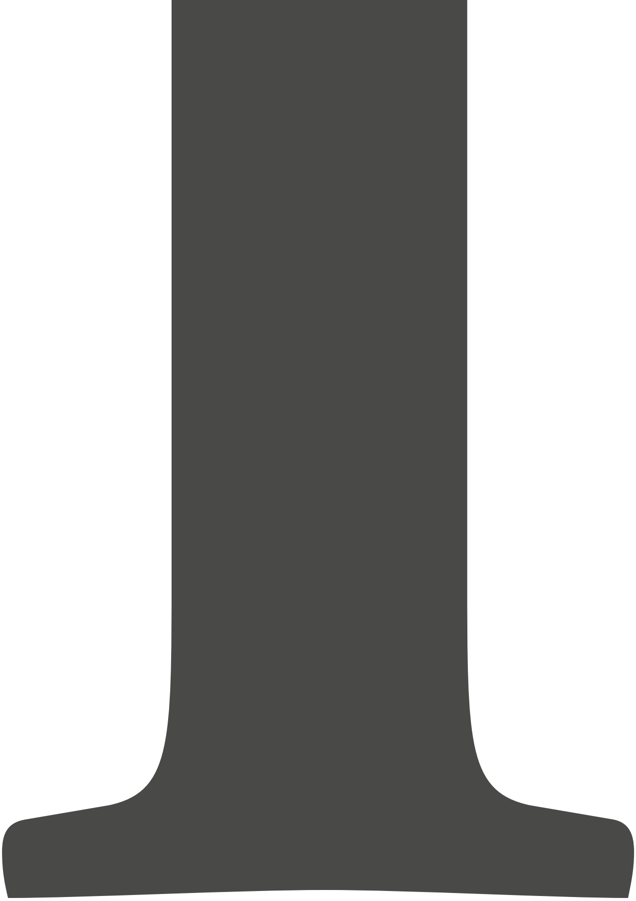


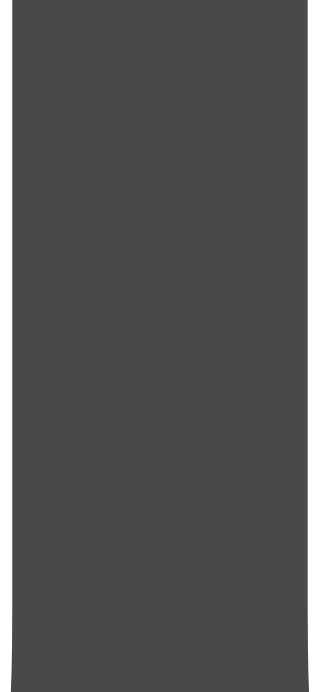


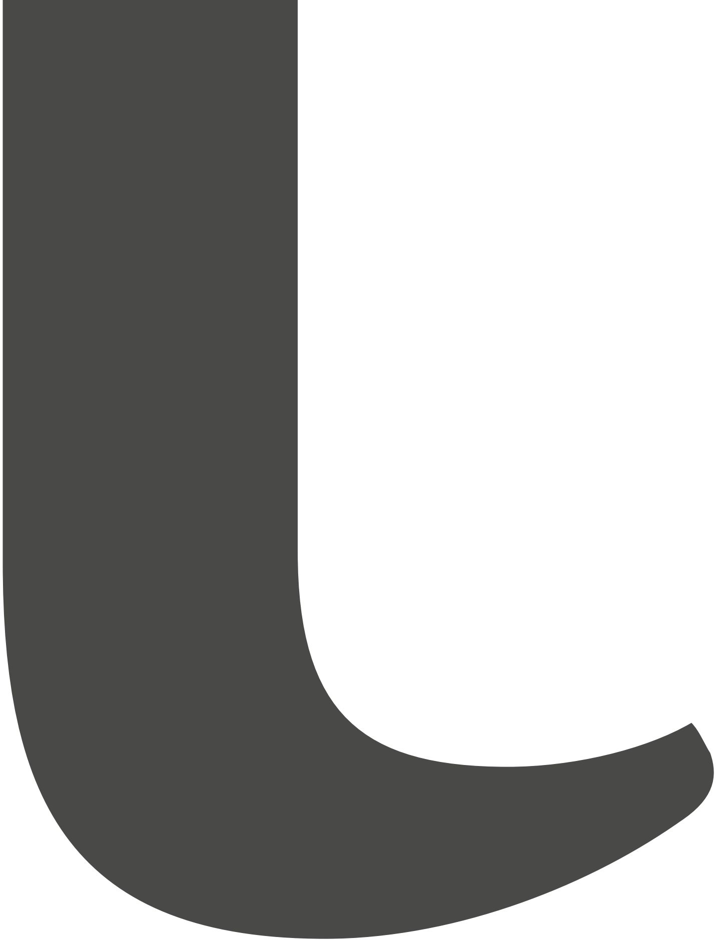
V







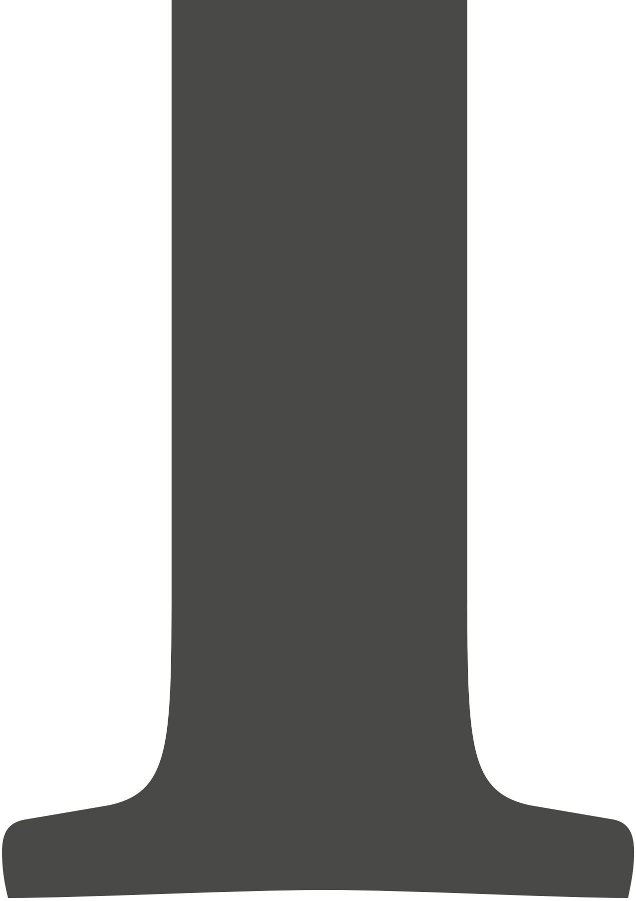


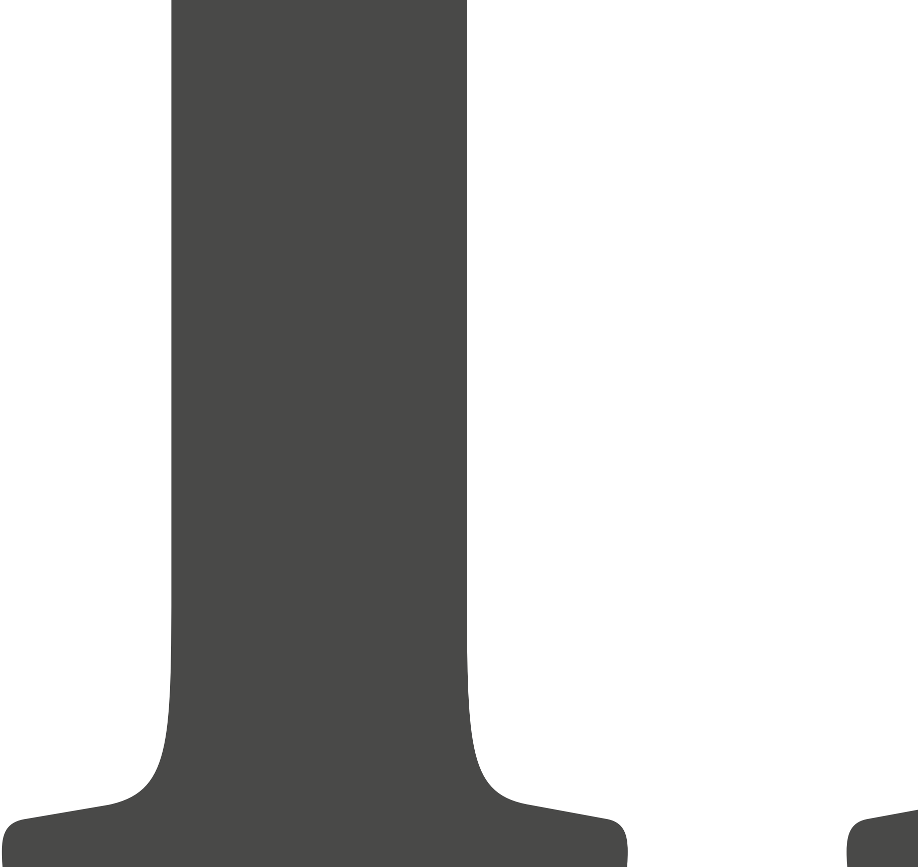


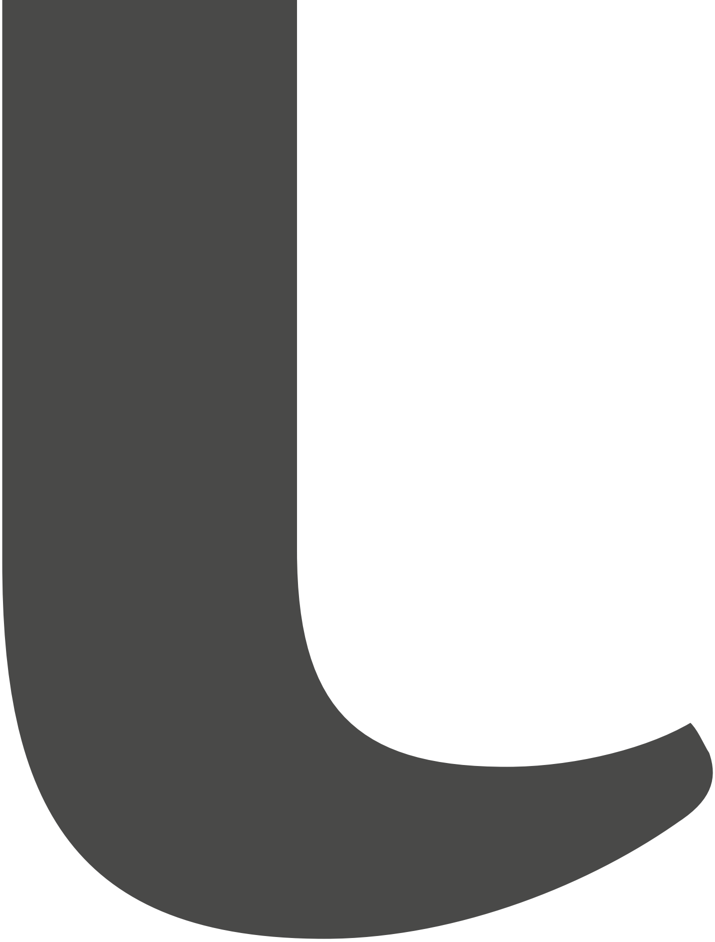
g

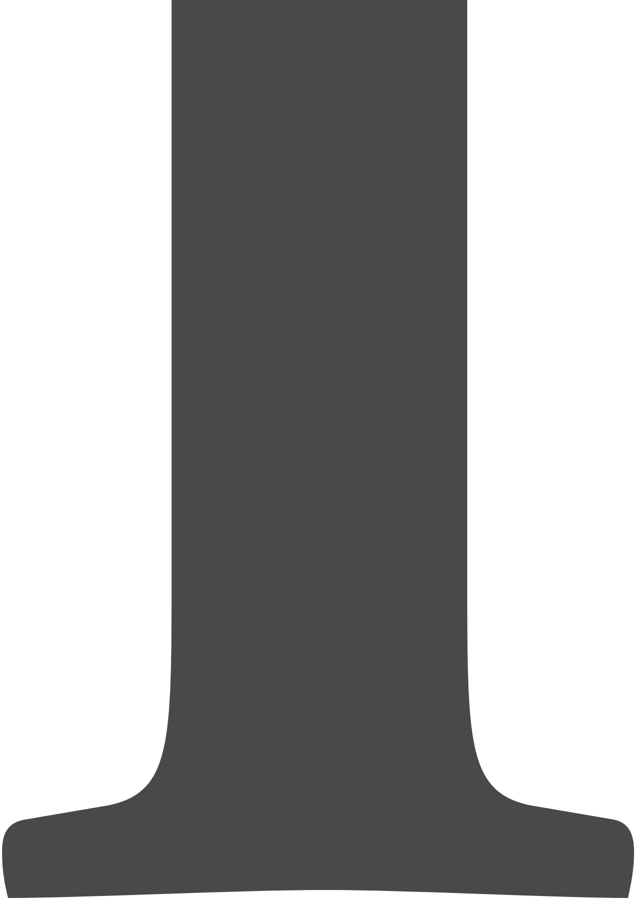
1

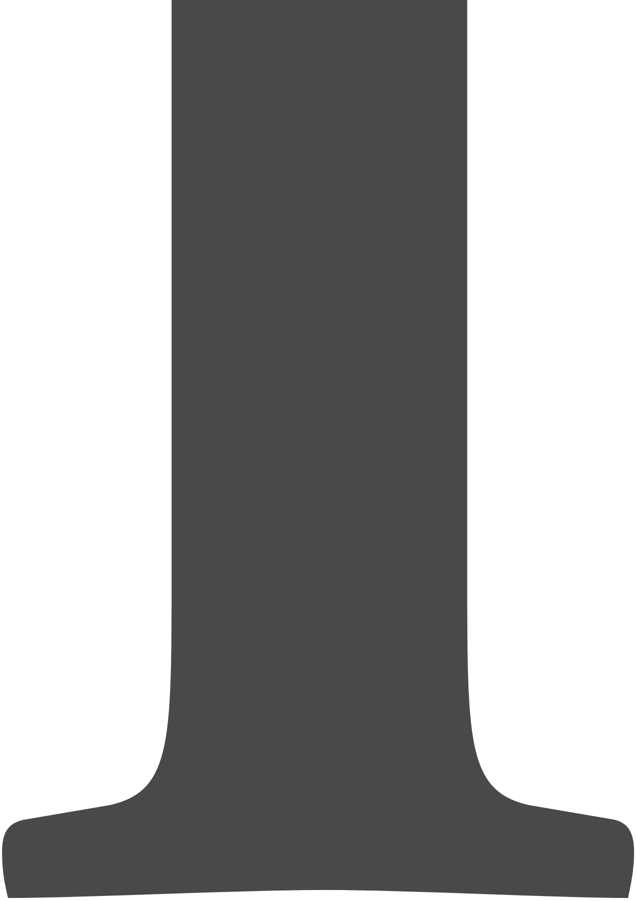
V

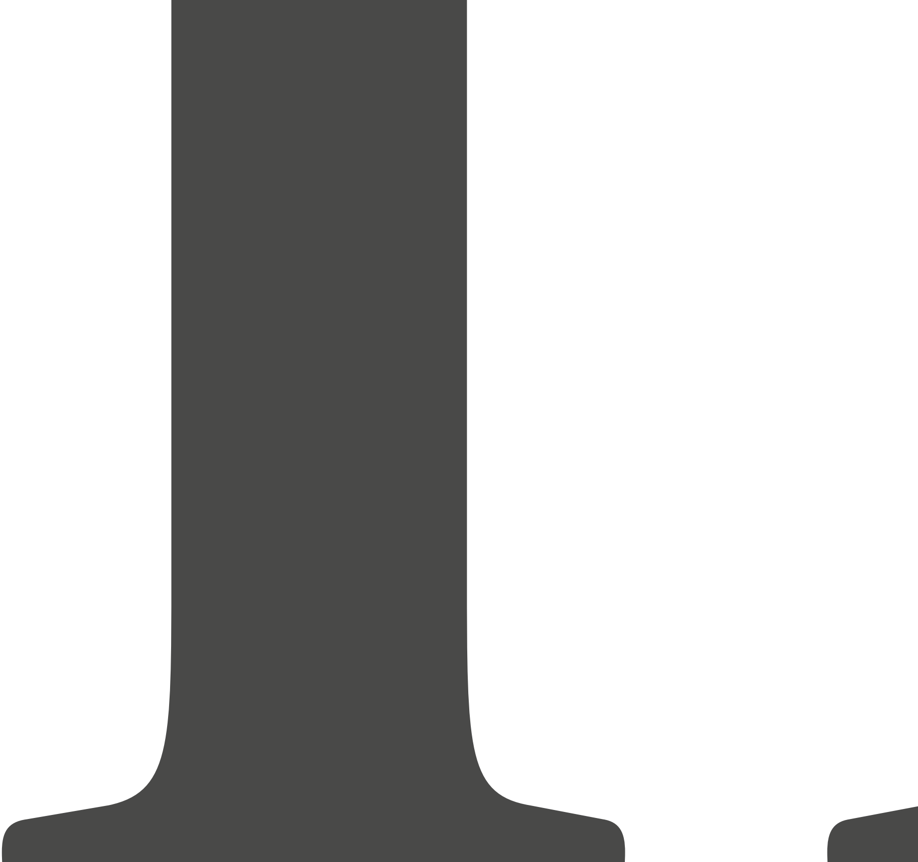


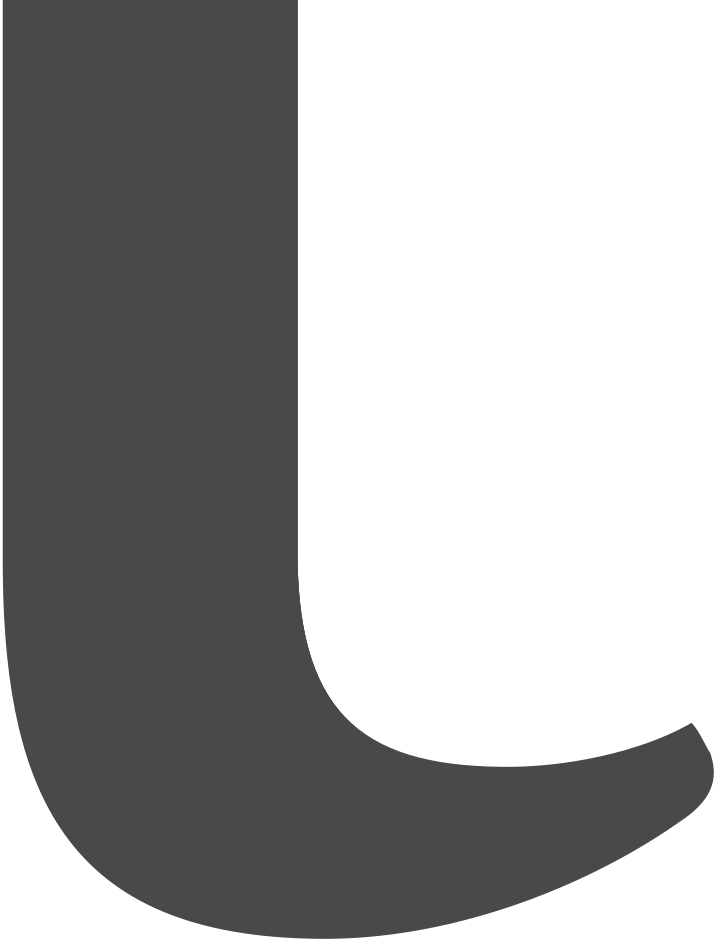


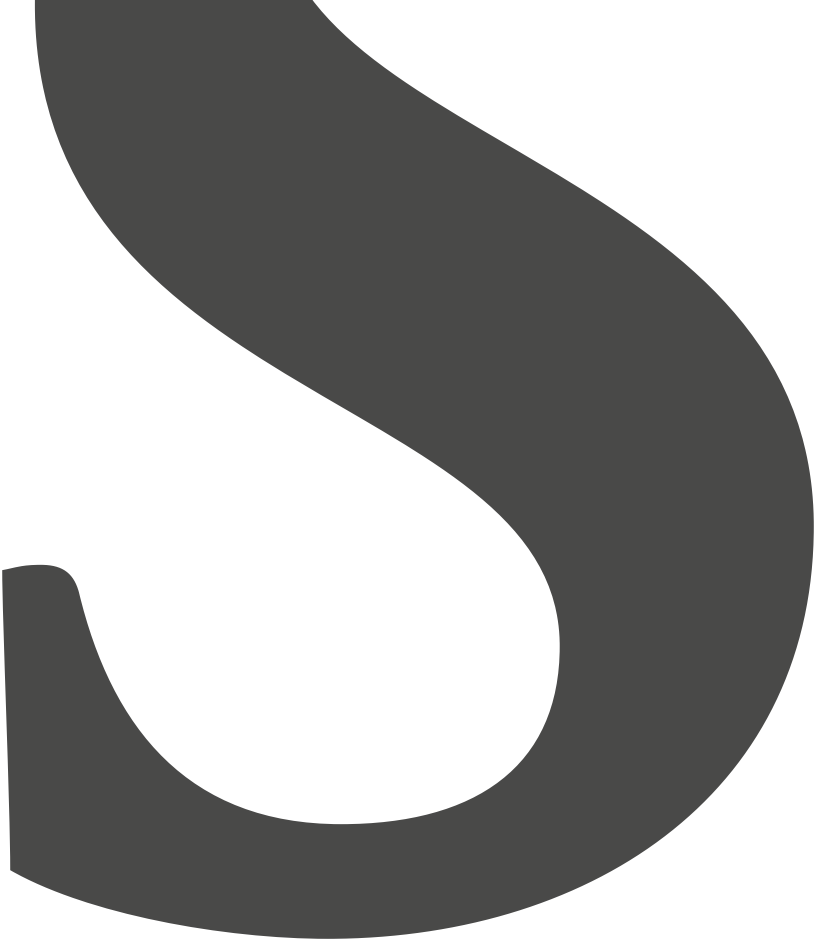


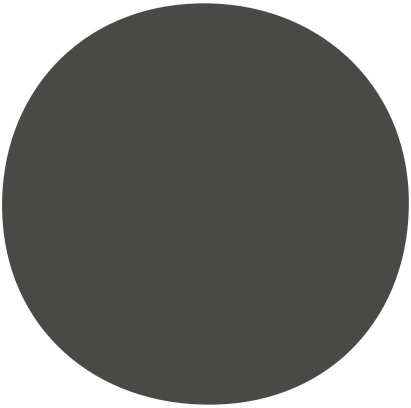




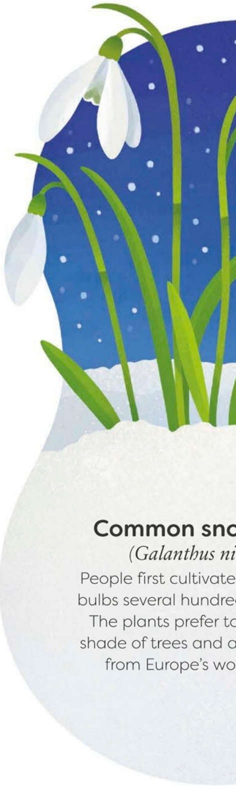








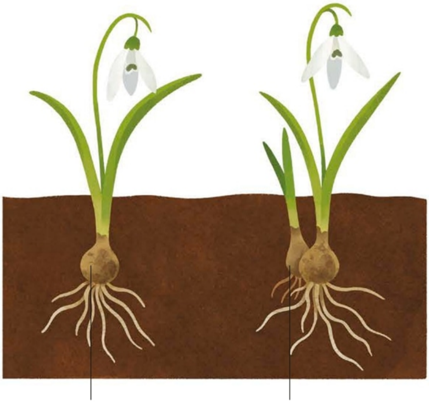
Snowdrop



Common sno

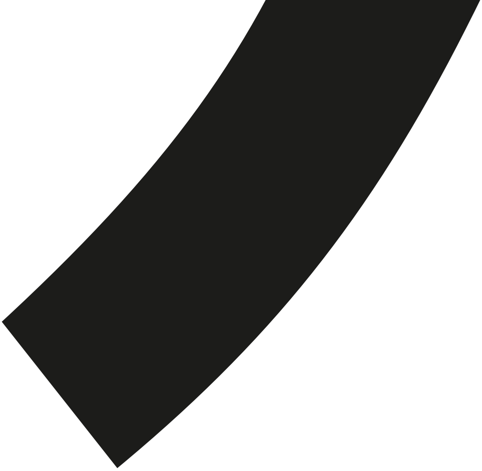
(Galanthus ni

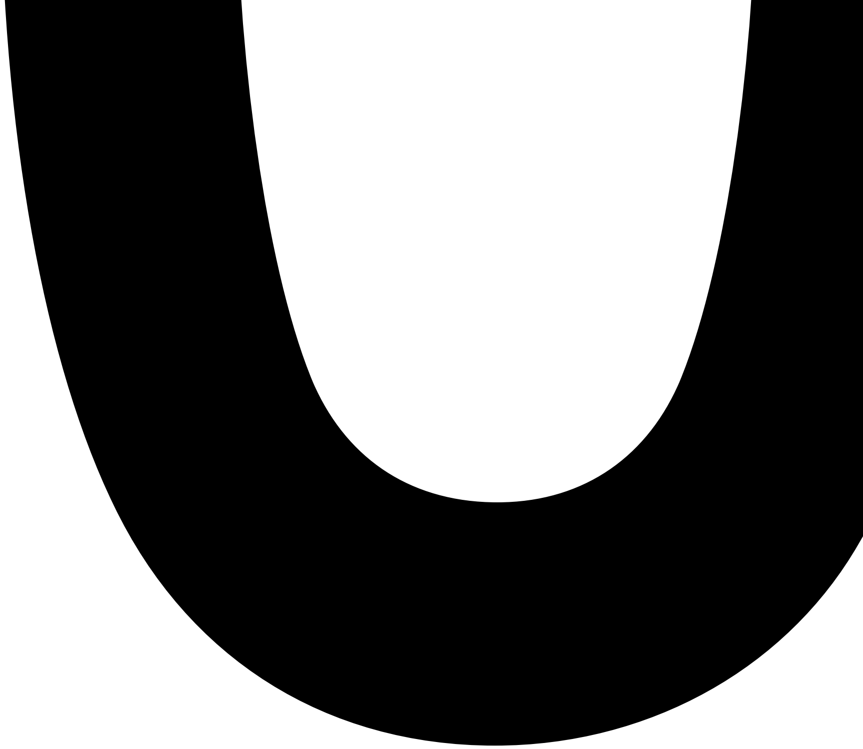
People first cultivate bulbs several hundre The plants prefer to shade of trees and a from Europe's wo

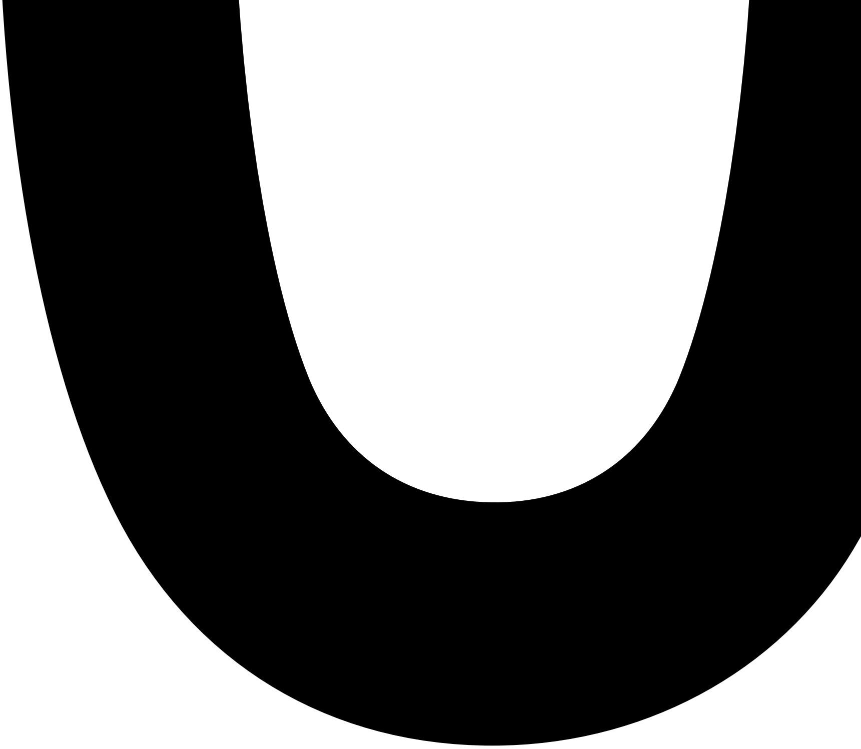


Baby bulblets

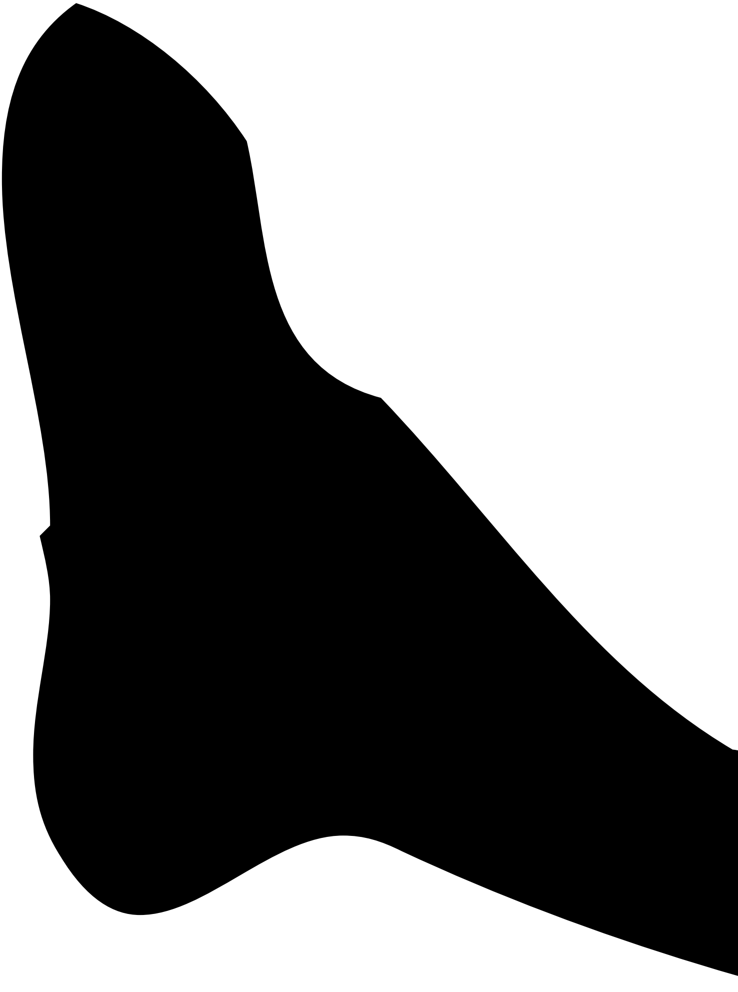
As well as spreading by seeds, snowdrop can spread directly from their bulbs. Older snowdrop bulbs develop buds, called bulblets, around the outside. The bulblets grow using energy from the parent bulb and send out roots of their own, then split off to form new plants.

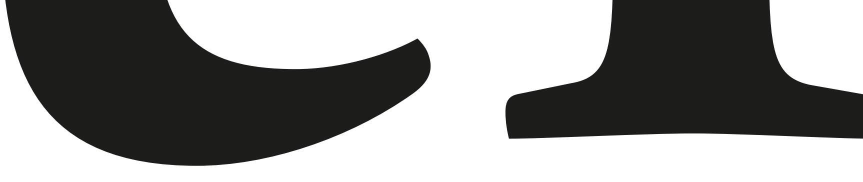






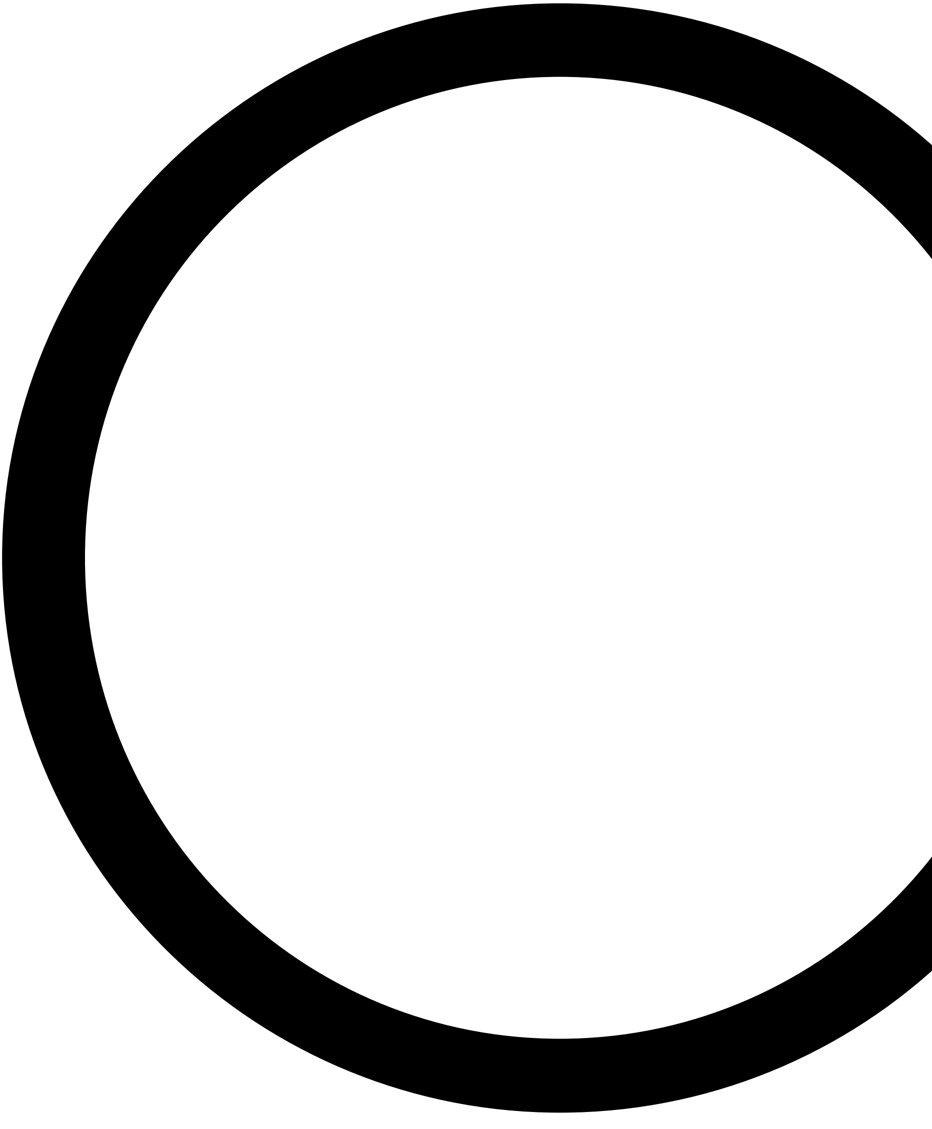
[redacted]





A

C



C

b

p

O

P

b

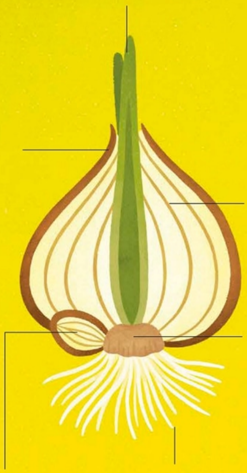
T

sh

fr

P

N



Inside a bulb

The base of a bulb grows roots and many layers of fleshy leaves, called scales, where it stores food and water. When conditions are right, the bulb sends up green leaves. Many bulbs are poisonous to eat.

S

B

R

S

B

S

In

p

th

T

in

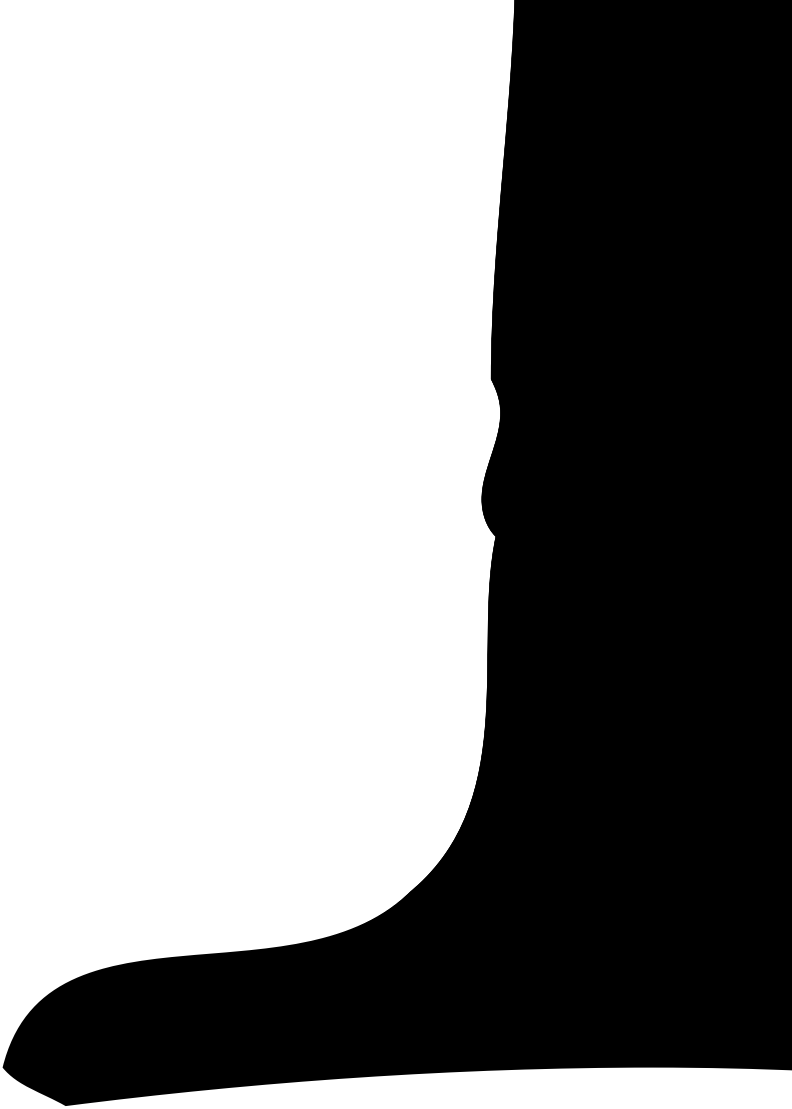
Li

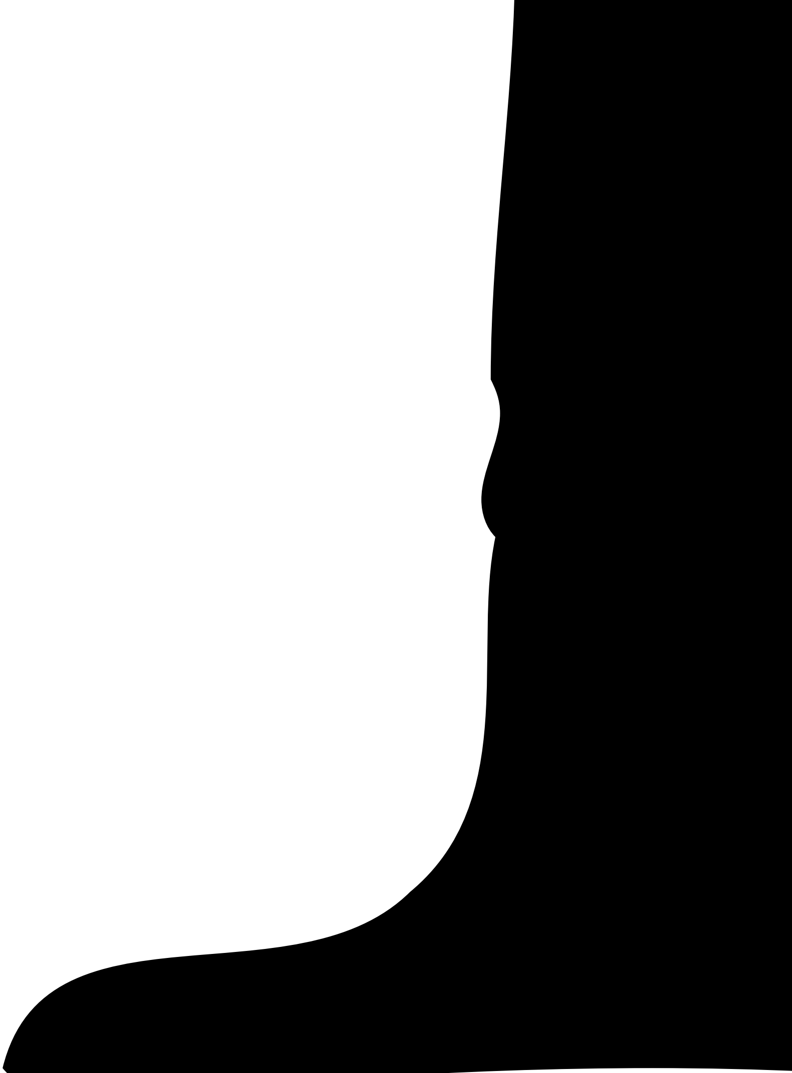
g

st

o

f





IV

N

fr

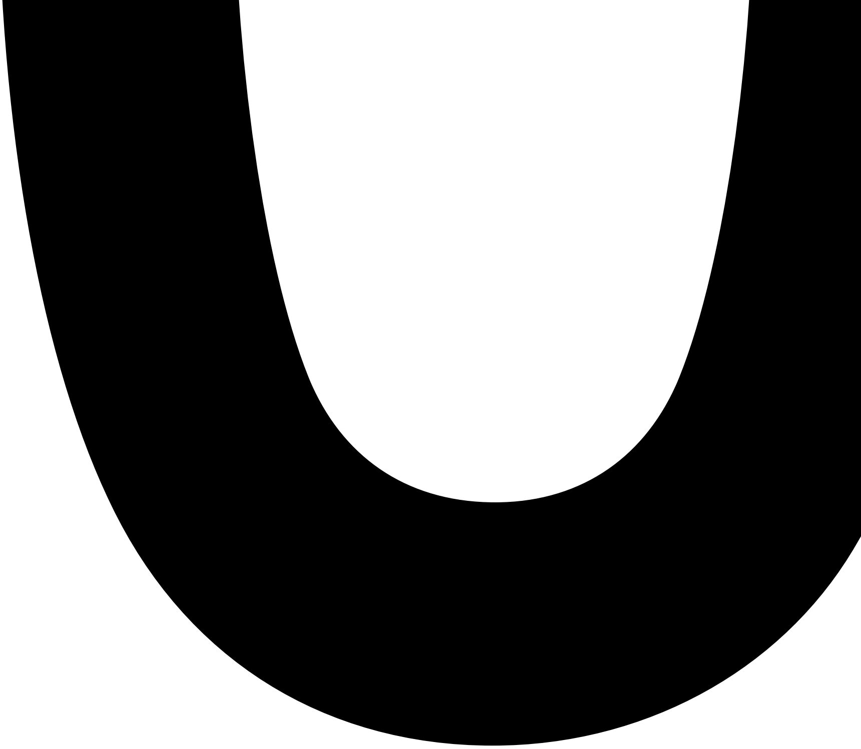
R

b

p

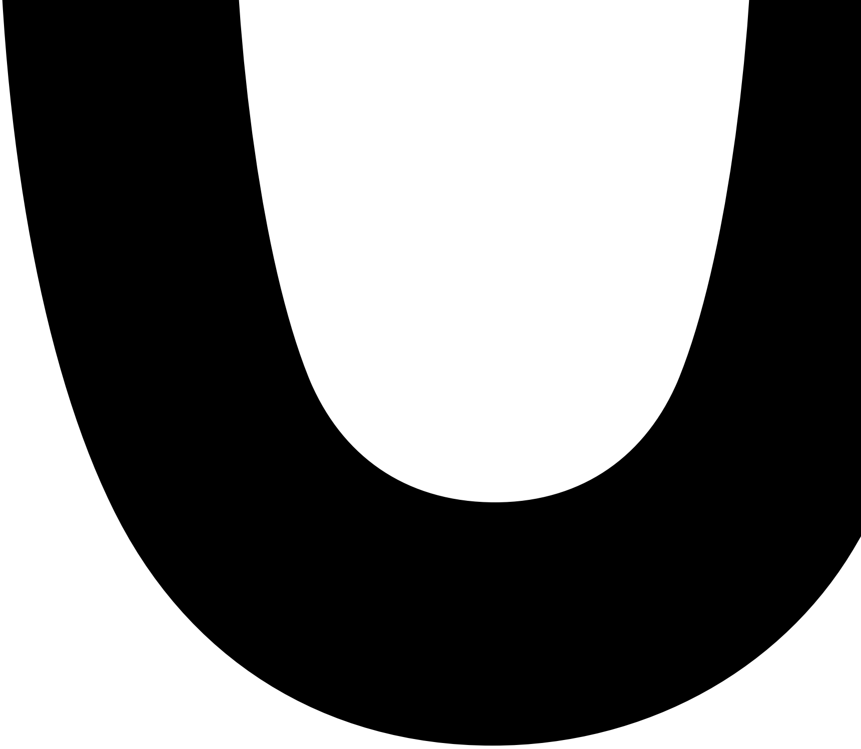
Underground stores

I



U

[redacted]

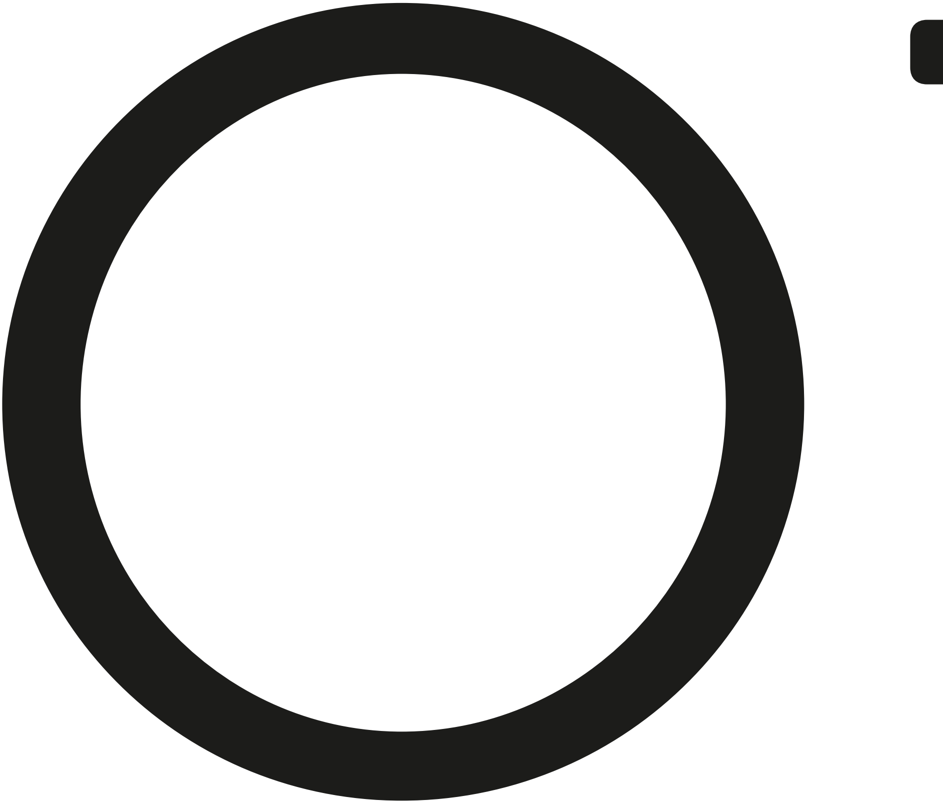


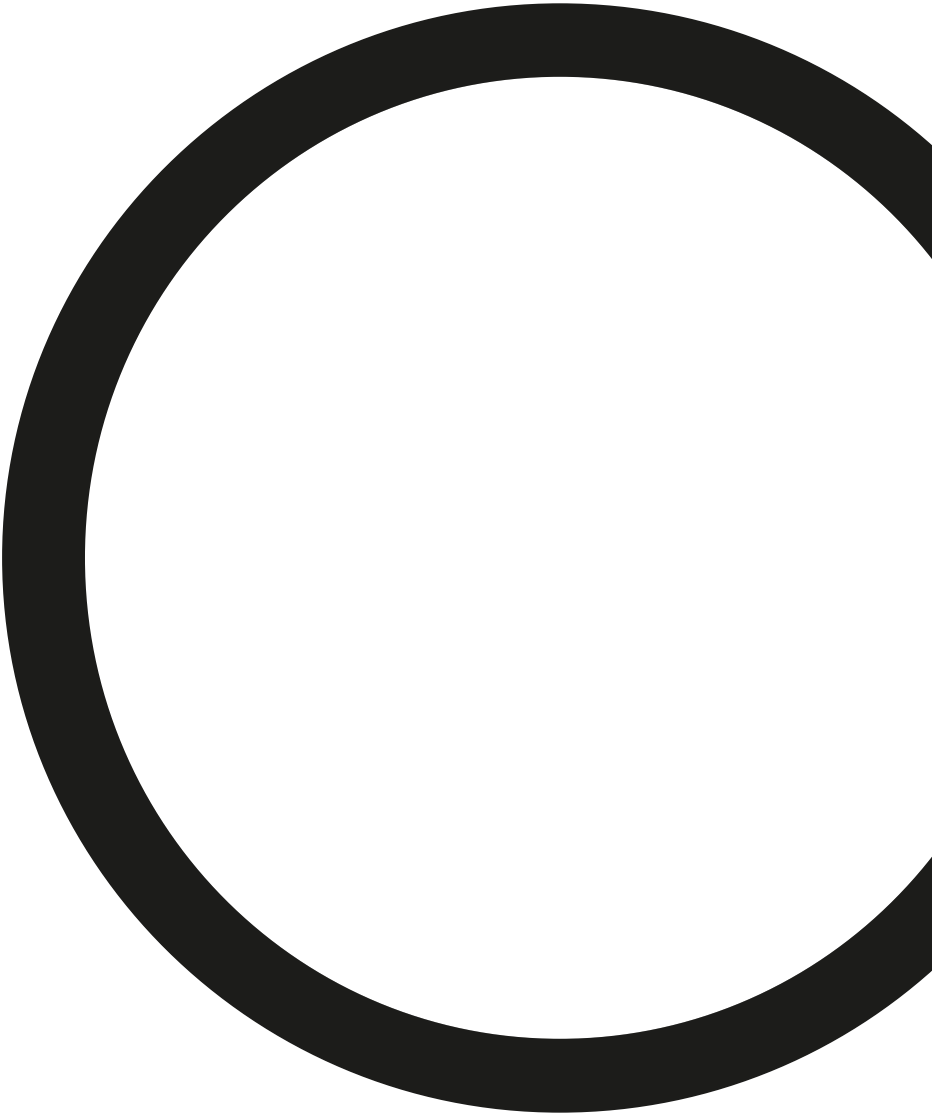
T

o

fl

sr





A

th

th

th

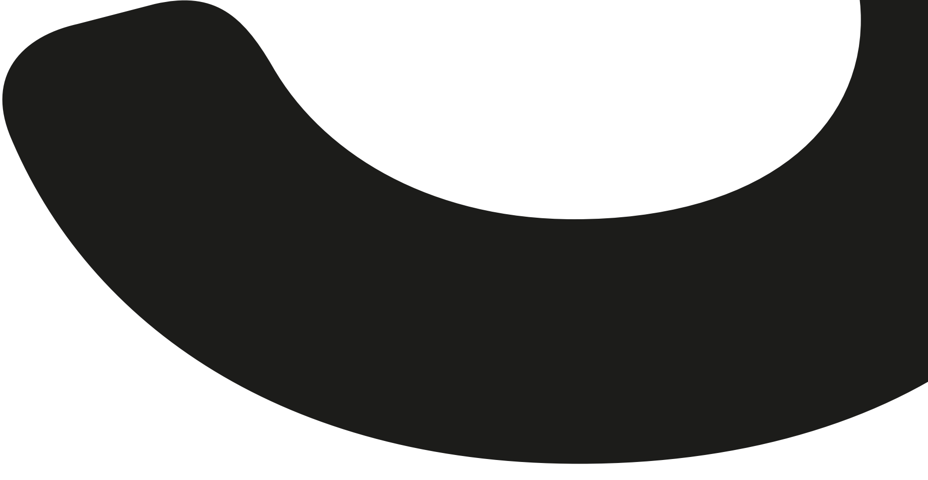
l

sp

a

st

W



T

p

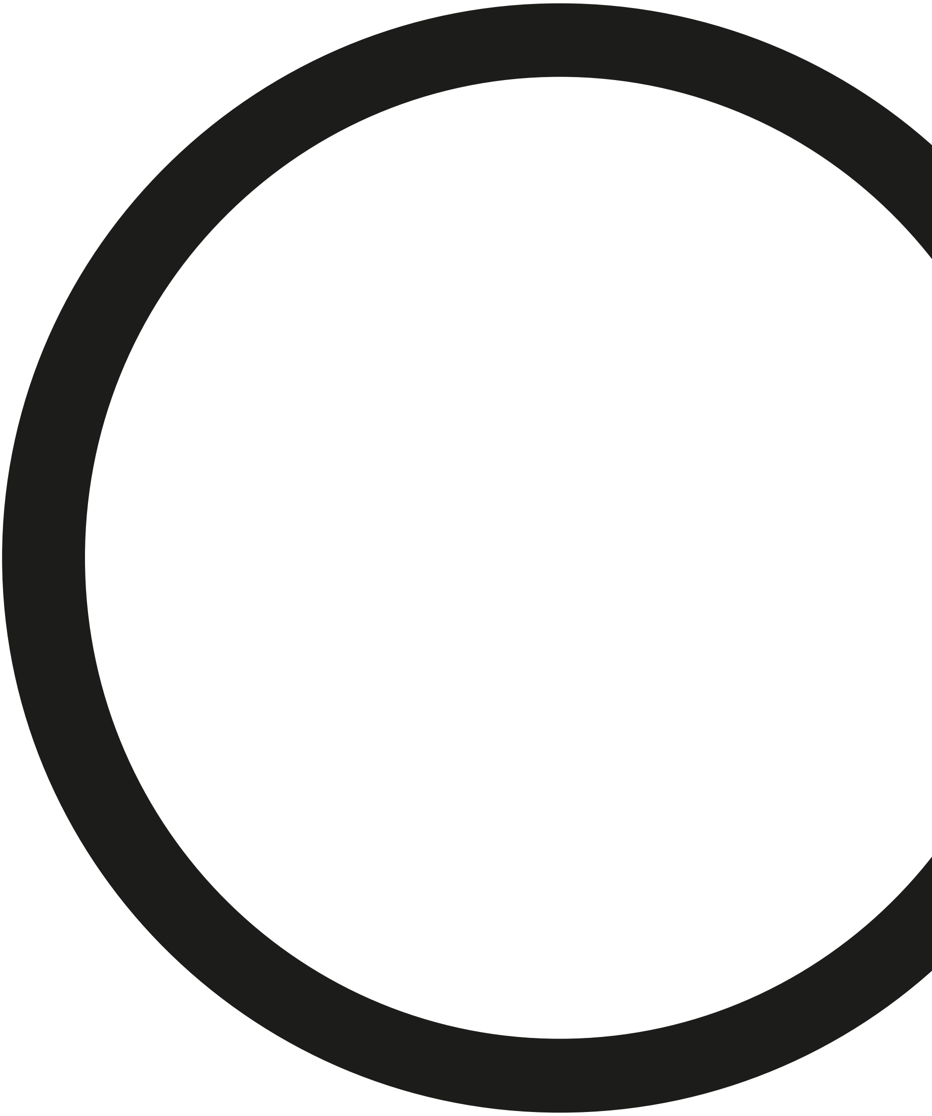
re

it

W

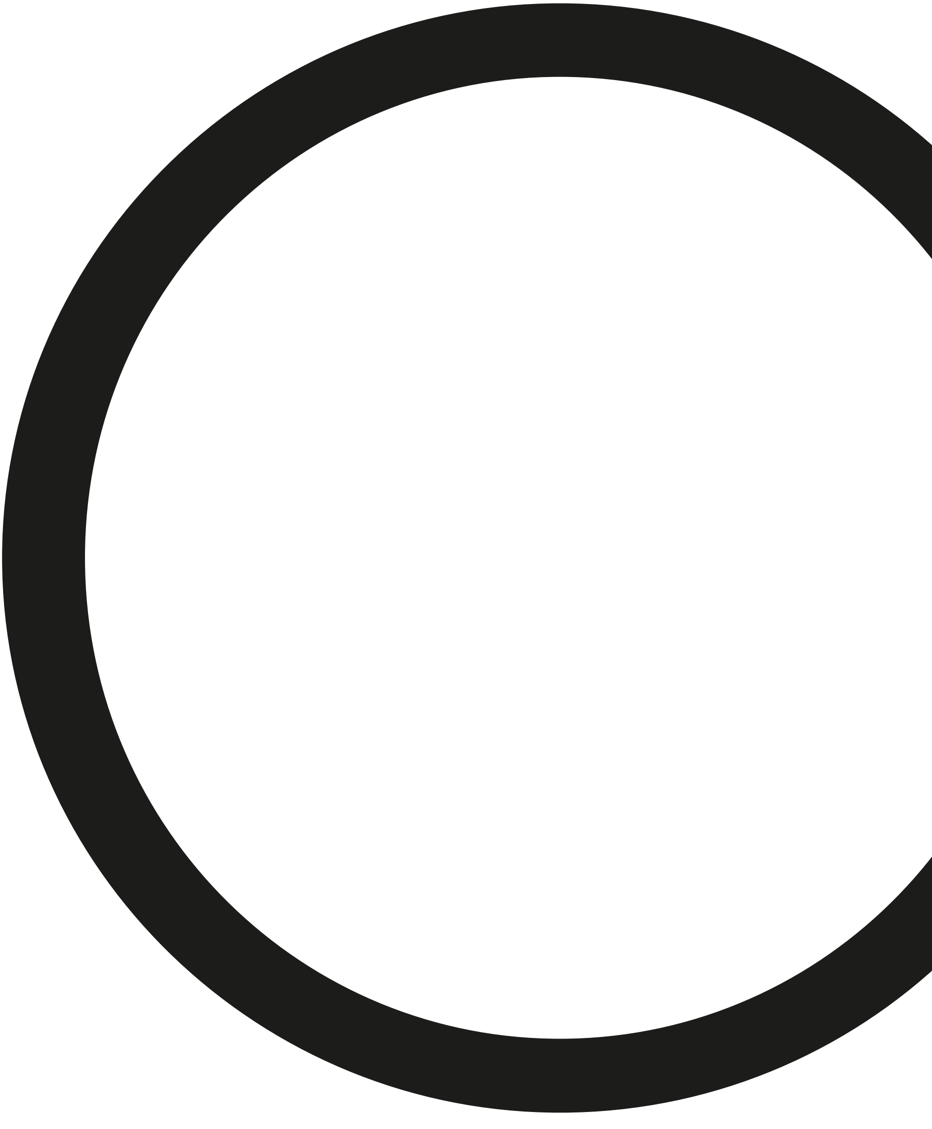
M

C



a

t

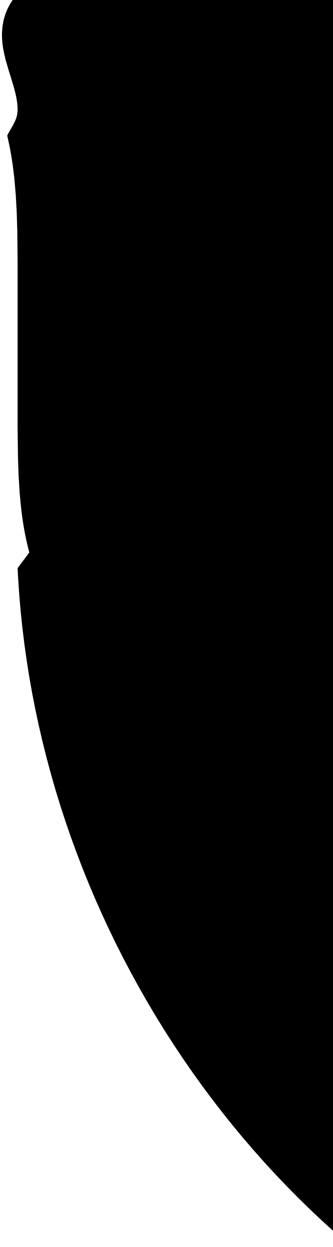


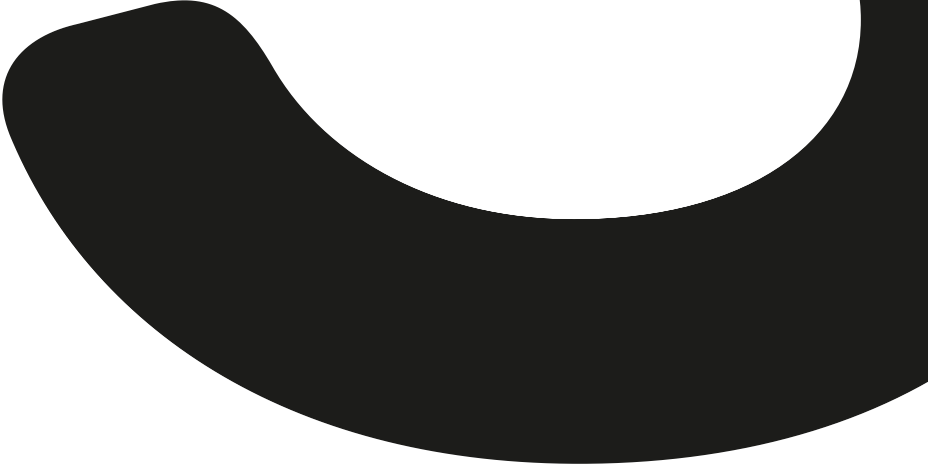
st

lik

th

p





T

V

W

A

b

I

A

sk

p

B

W

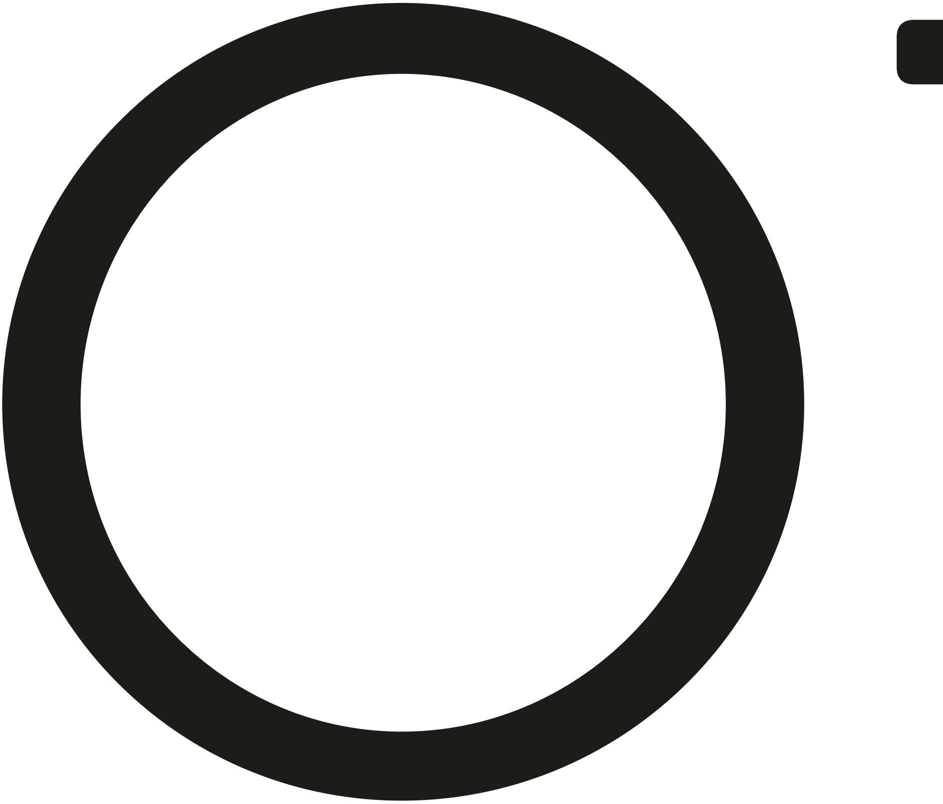
e

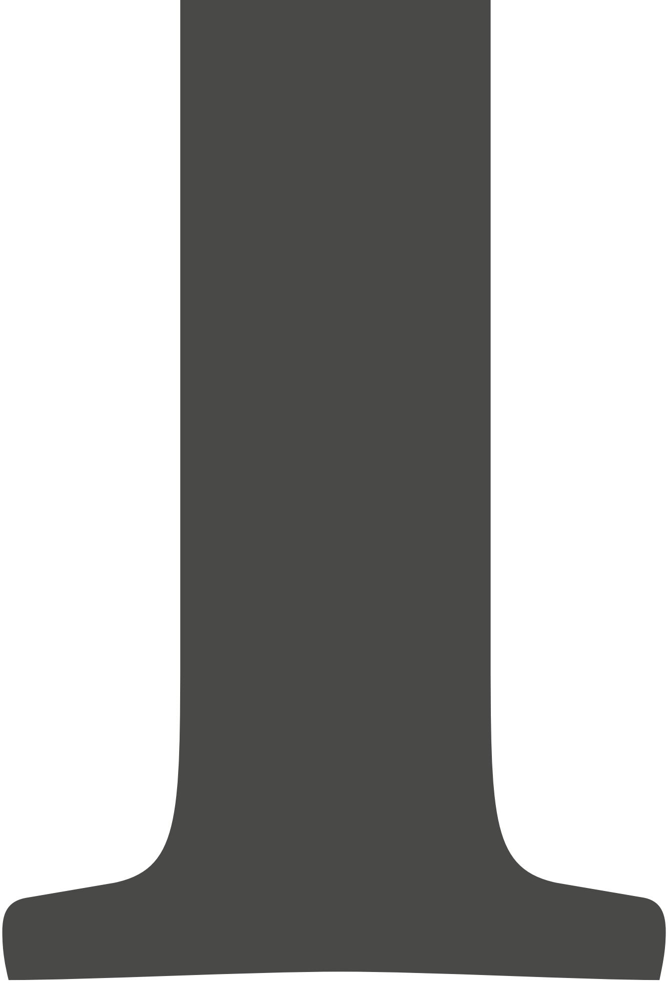
N

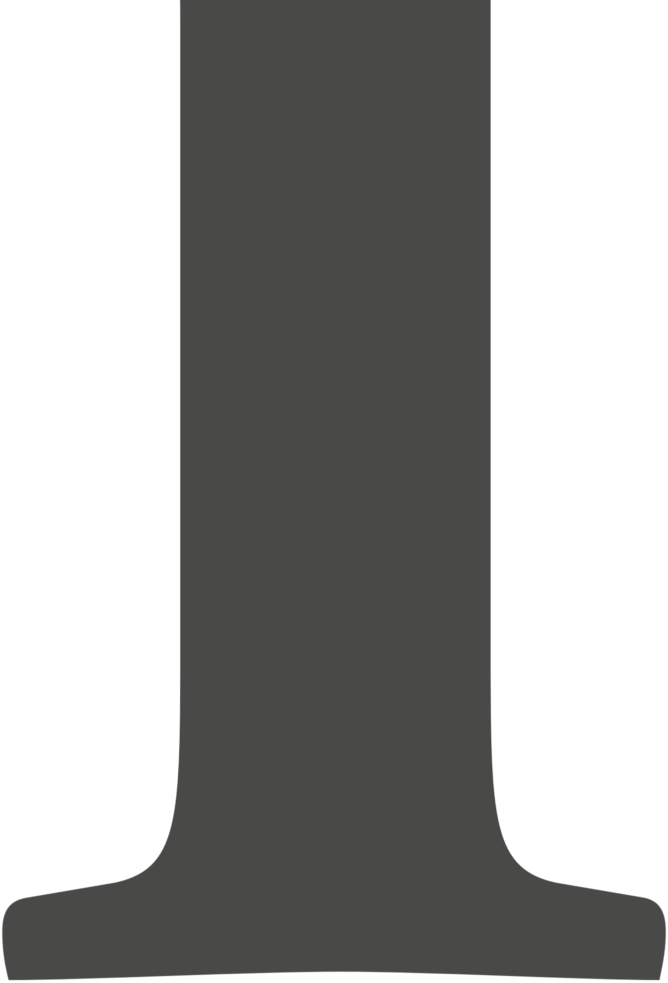
h

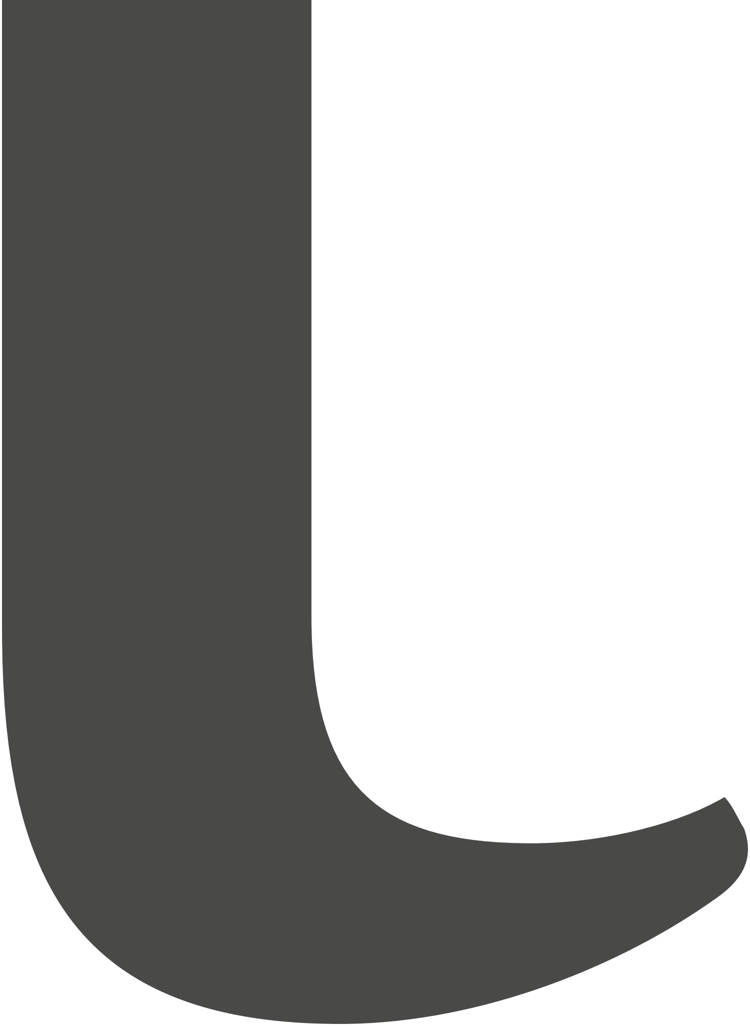
b

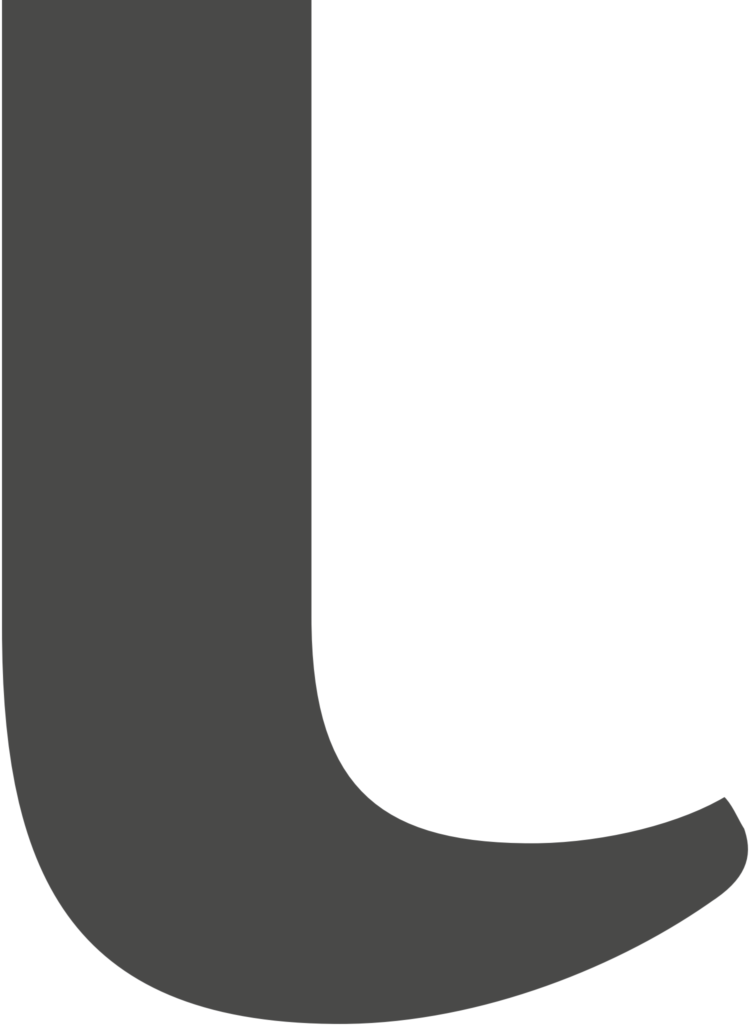
a

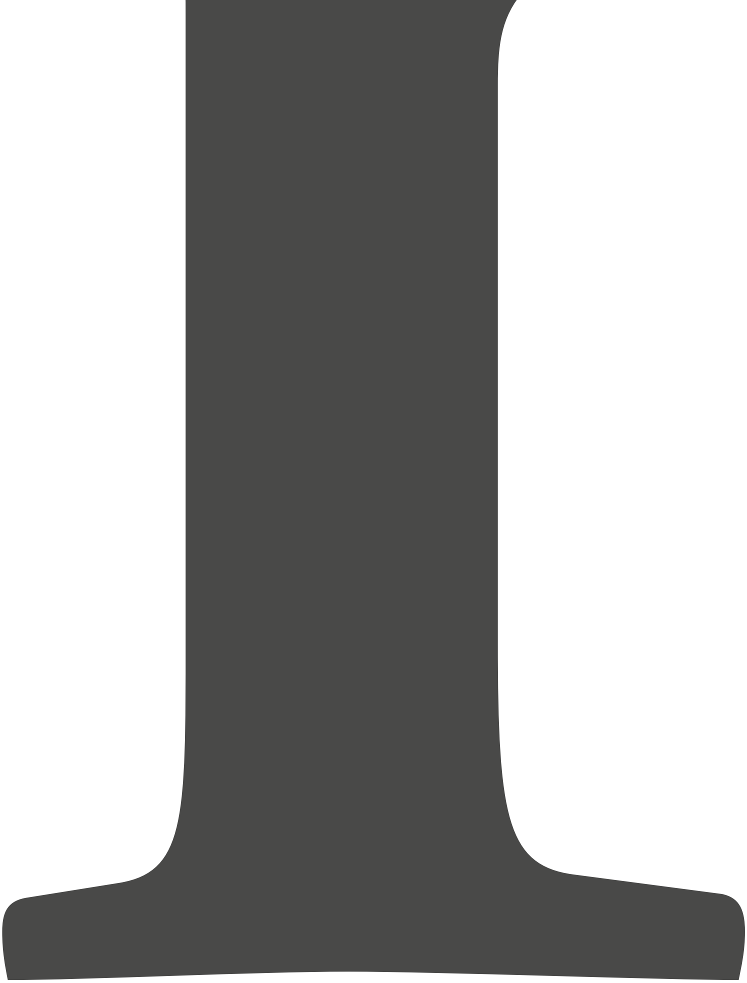


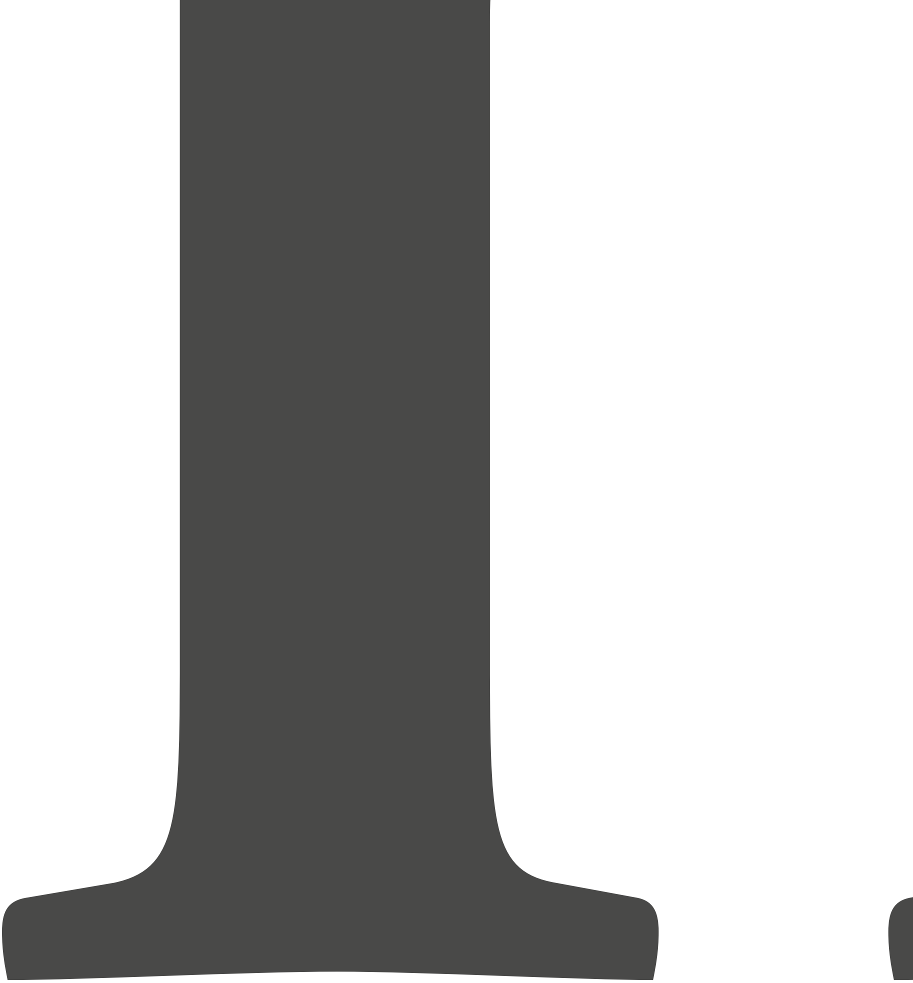


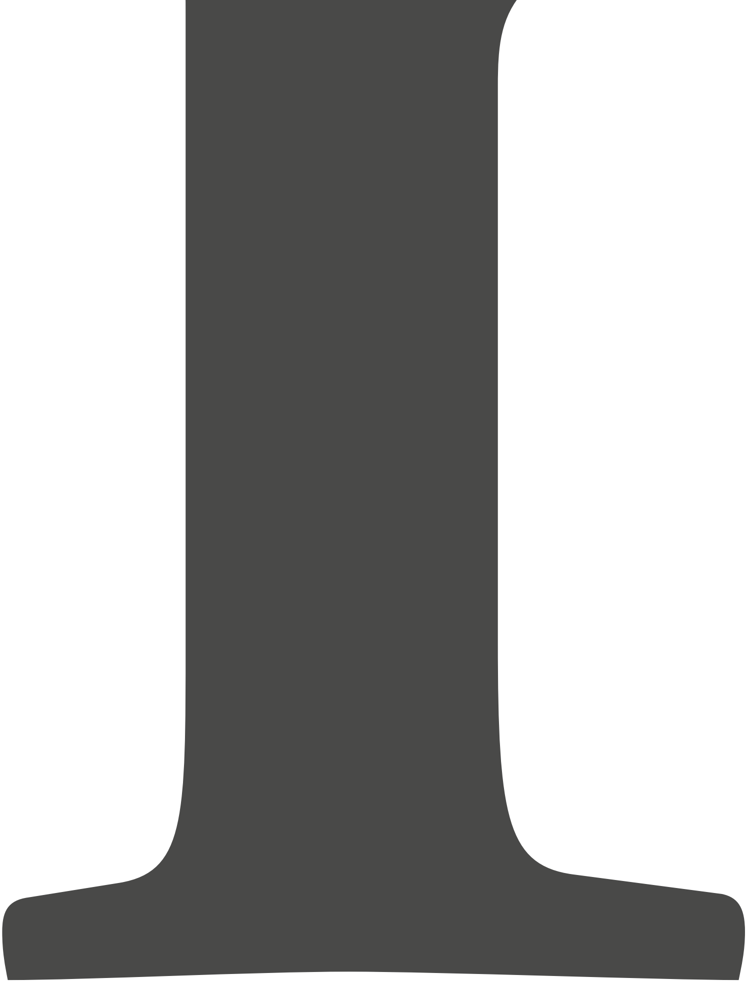




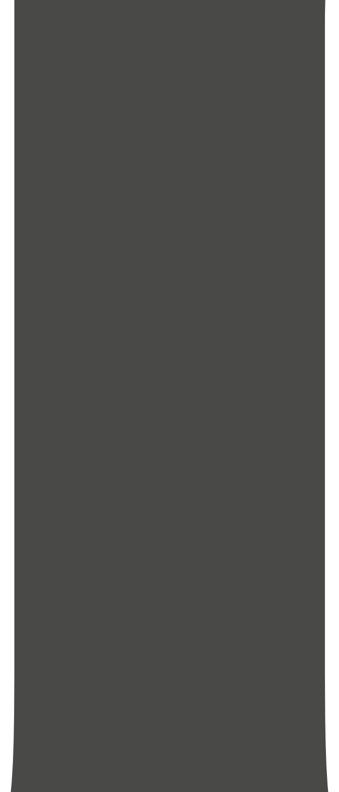


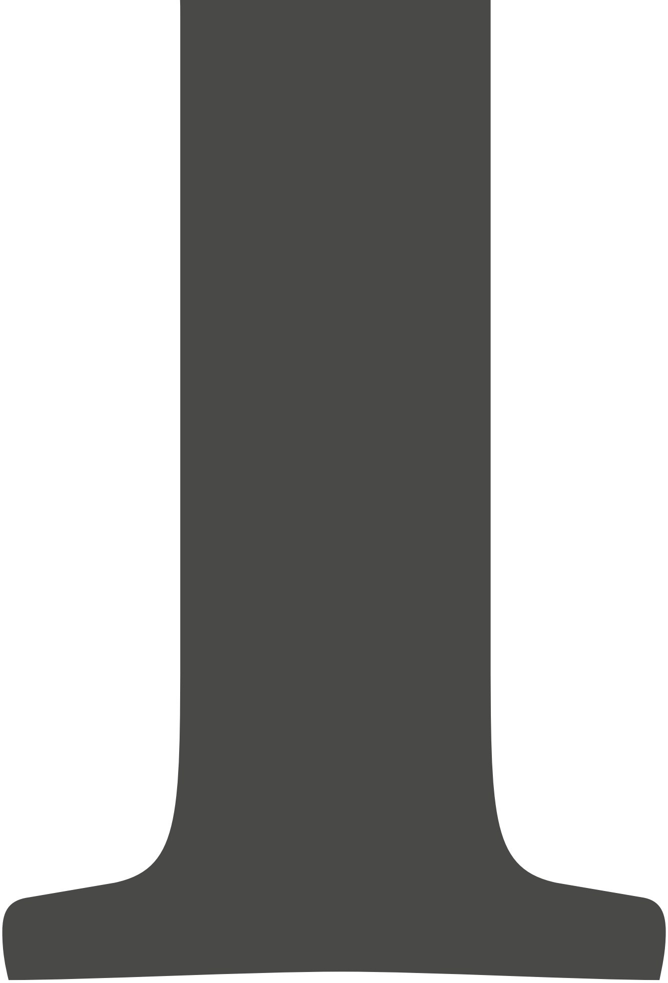


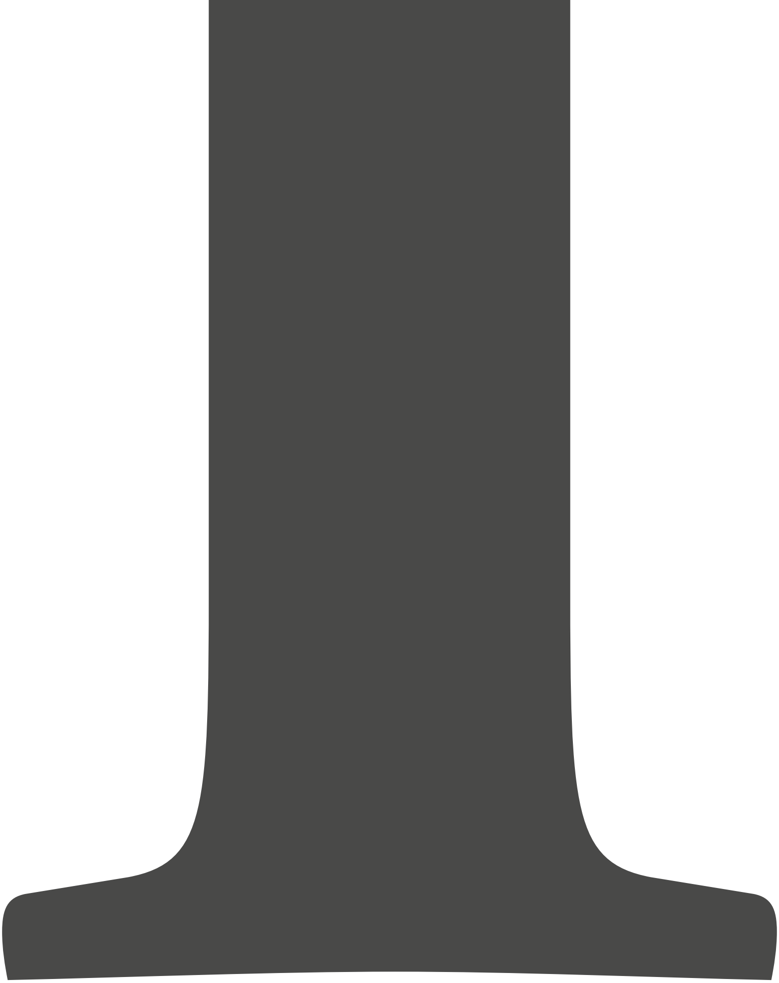


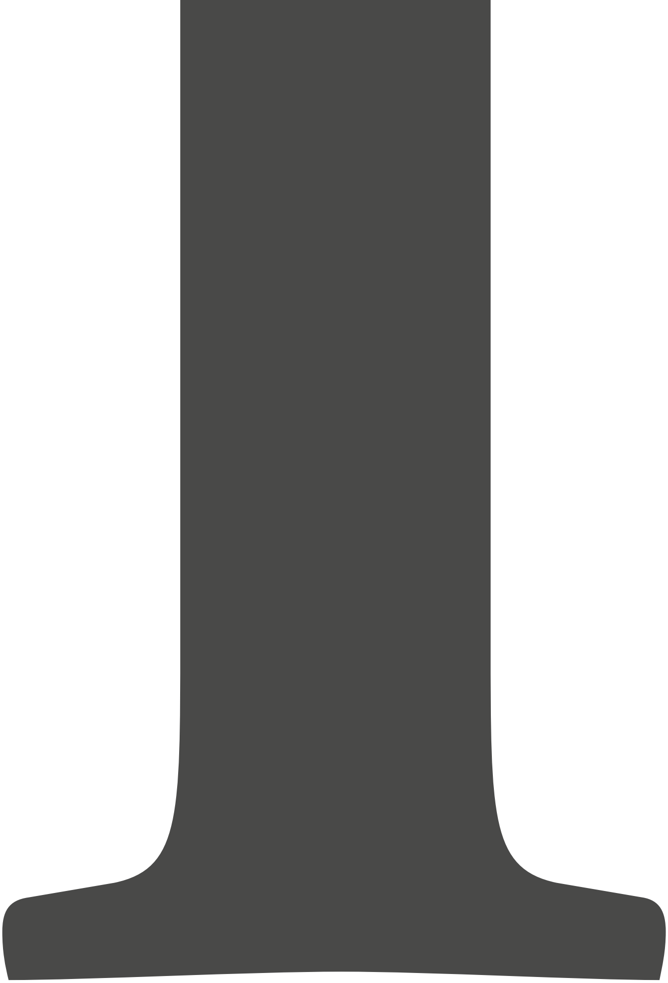


I

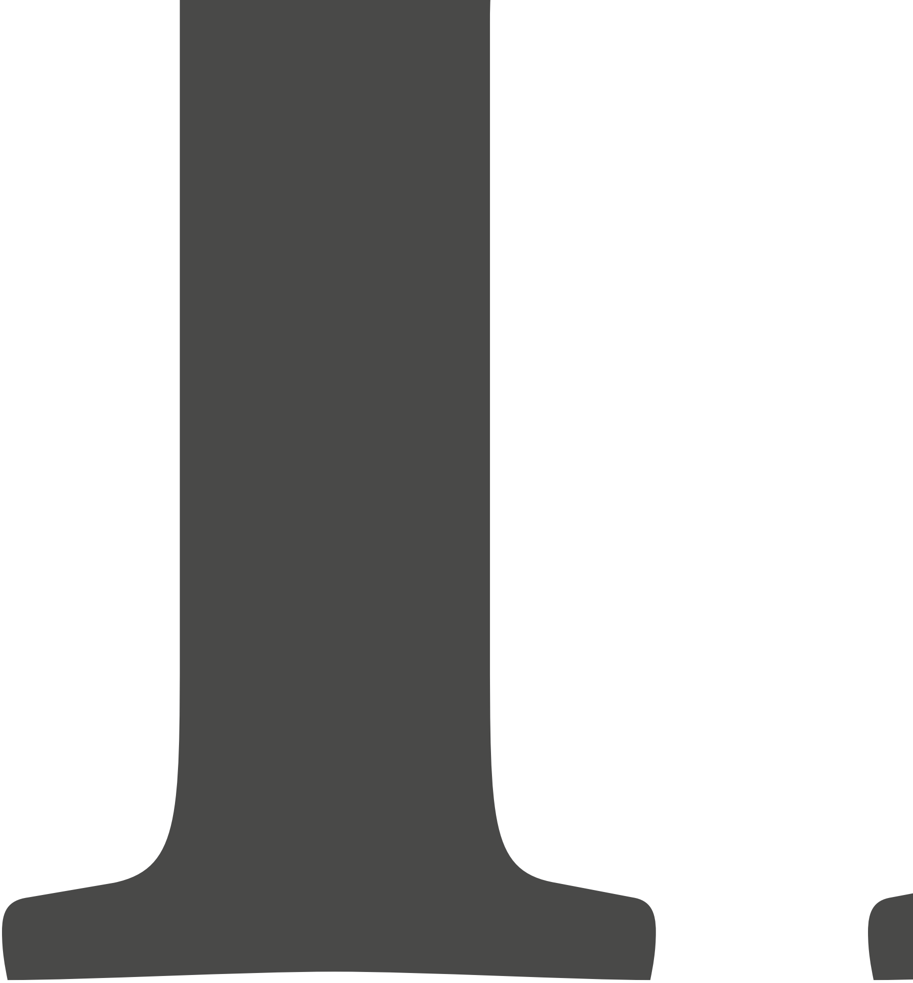


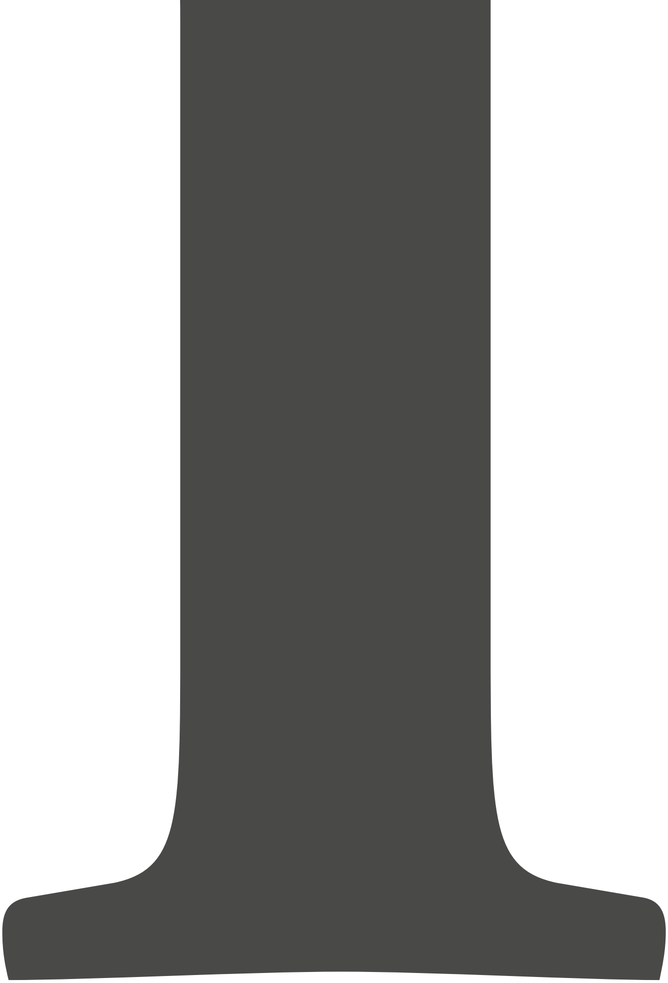


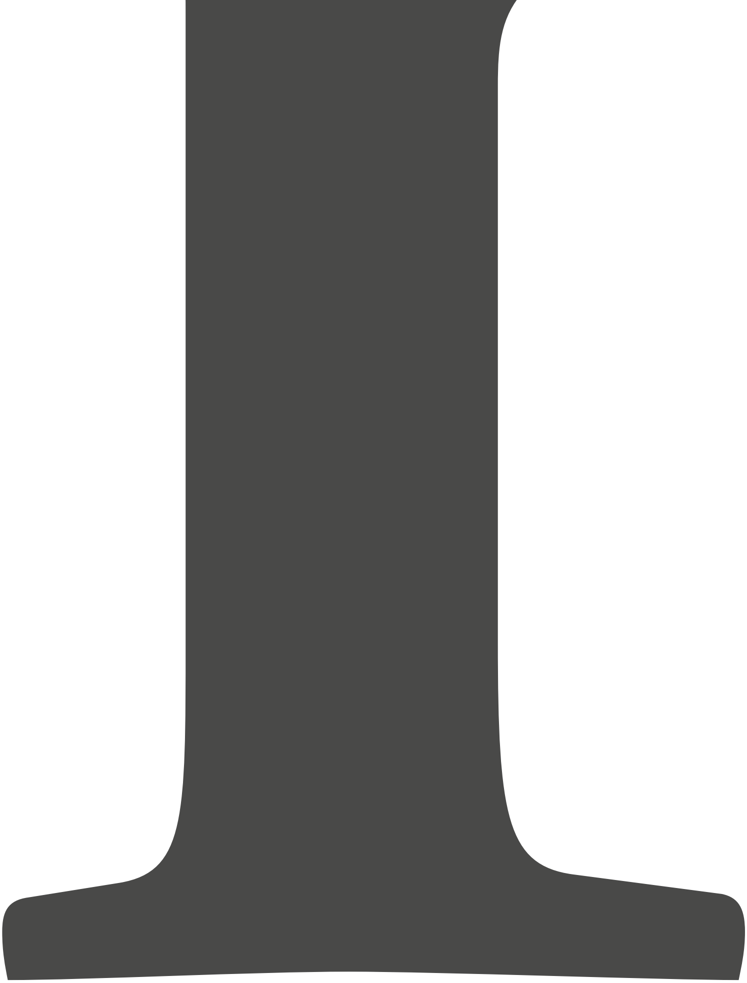


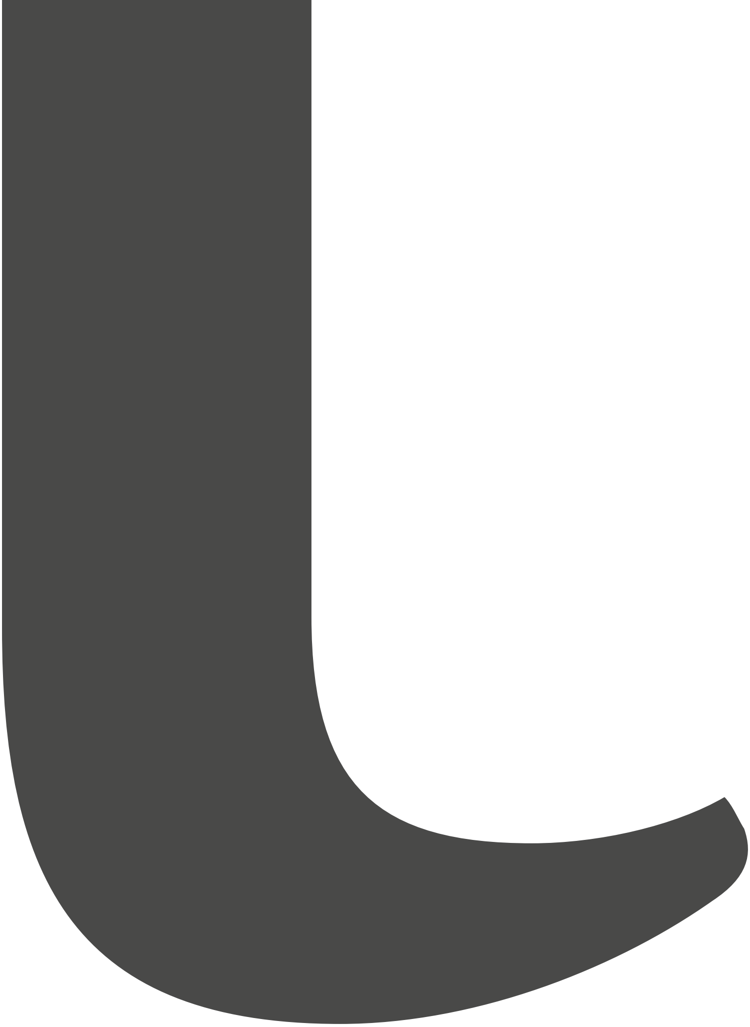


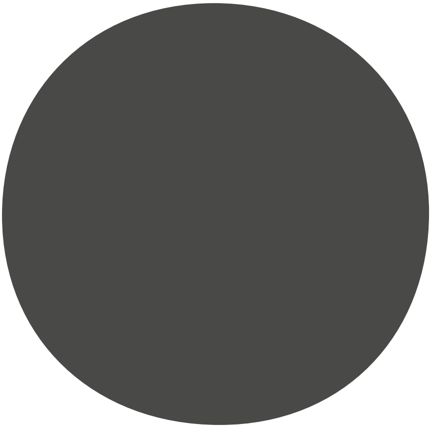
a



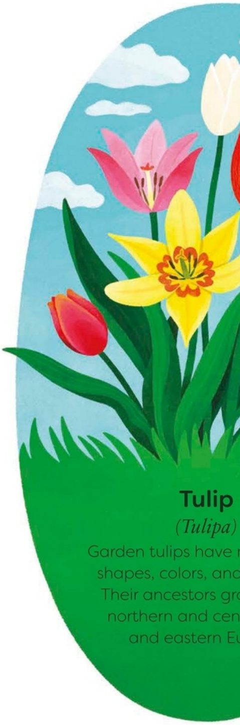








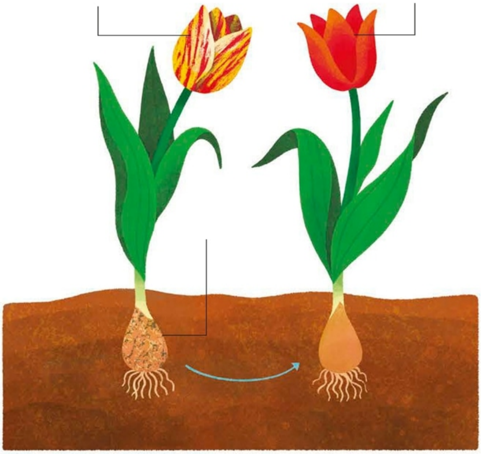
Tulip



Tulip

(Tulipa)

Garden tulips have
shapes, colors, an
Their ancestors gr
northern and cen
and eastern E



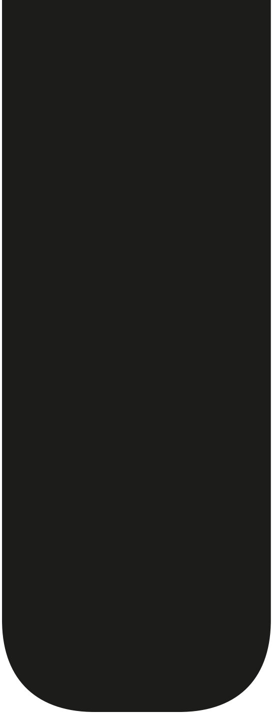
Infected bulb

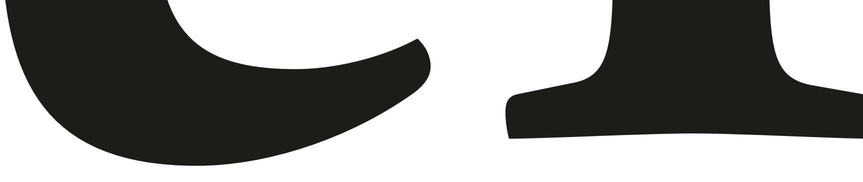
Tulip petals sometimes have streaks of other colors. In the past, these marks were caused by a virus that infected the bulb. If the infection spread to other bulbs, those tulips also often became streaky. Today, multicolored petals have been bred on purpose.

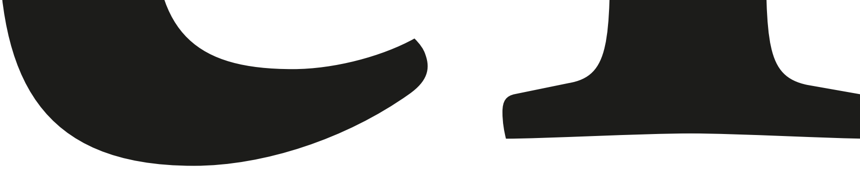
[redacted]

U

[redacted]







T

O

m

in

sp

a

m

b

l

b

H

lr

G

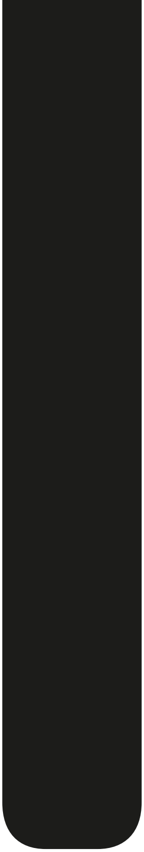
sh

T

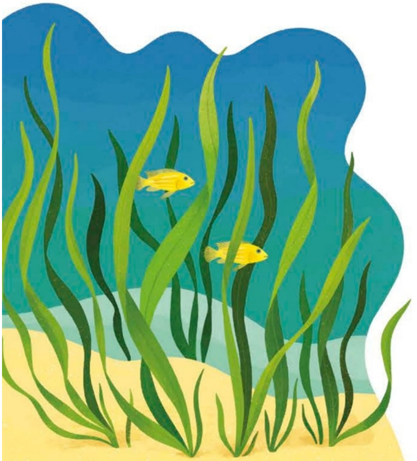
n

a

Flowers



Seagrass



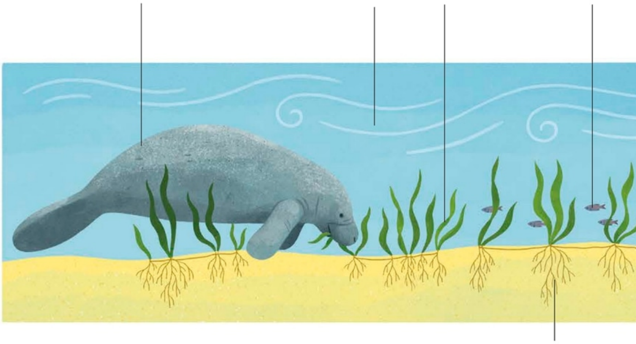
Tape seagrass

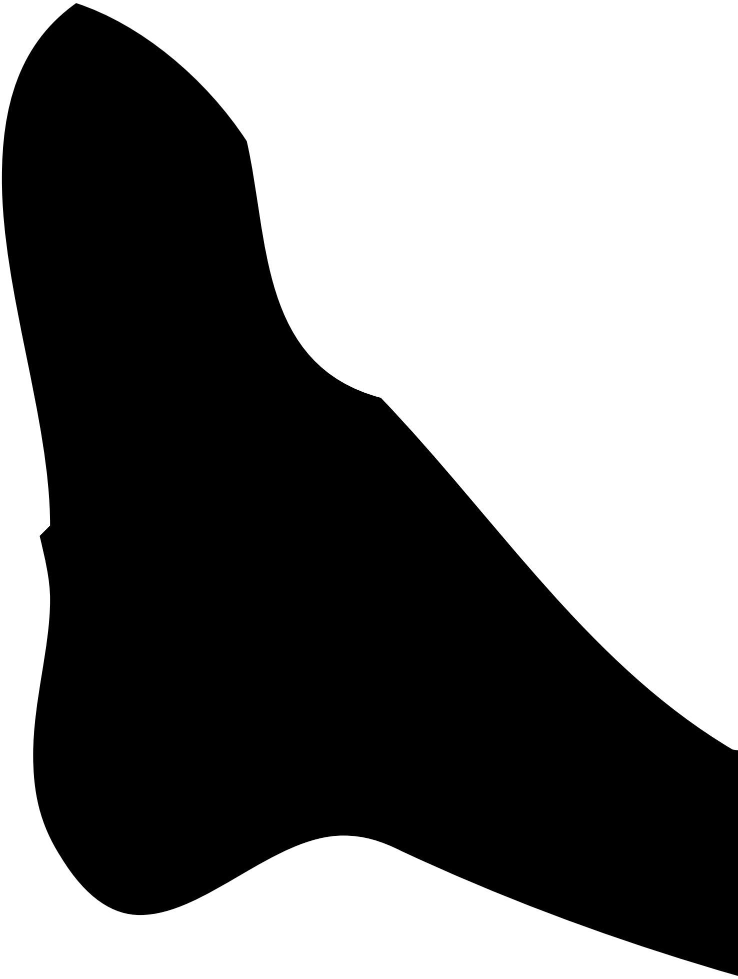
(Enhalus acoroides)

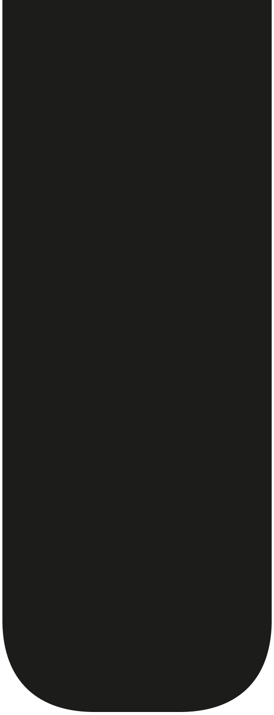
Seagrasses look like grass, but they belongs to different families of plants. The largest meadows of seagrass are in bays and river mouths. This species grows in warm parts of the Indian and Pacific Oceans.

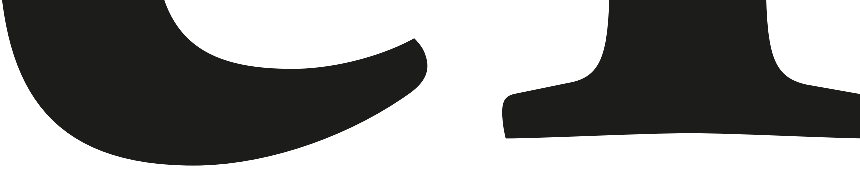
Seagrass ecosystem

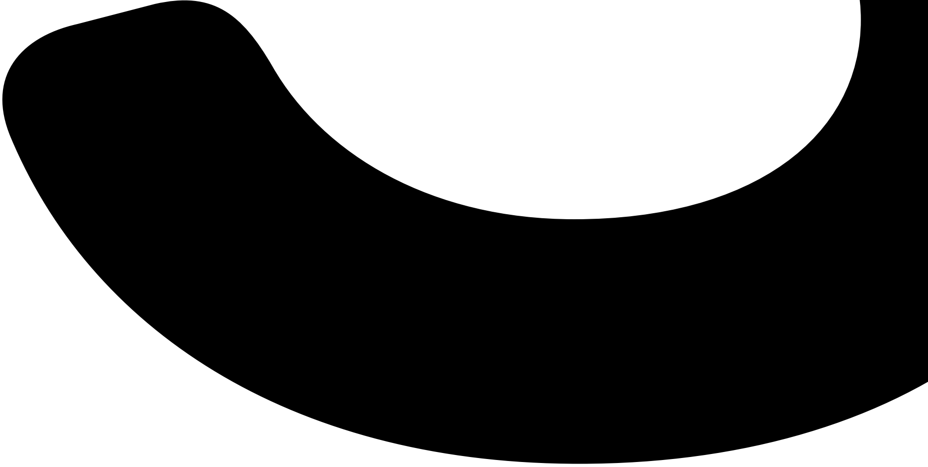
Seagrass shapes and protects an ocean ecosystem. Its roots hold onto mud and sand, and its leaves slow ocean currents, which prevents the seabed from washing away. Its leaves also shelter small animals and are food for species such as manatees.











S

a

h

it

w

fr

a

a

a

S

b

fo

m

b

sp

th

M

C

S

S

R

L

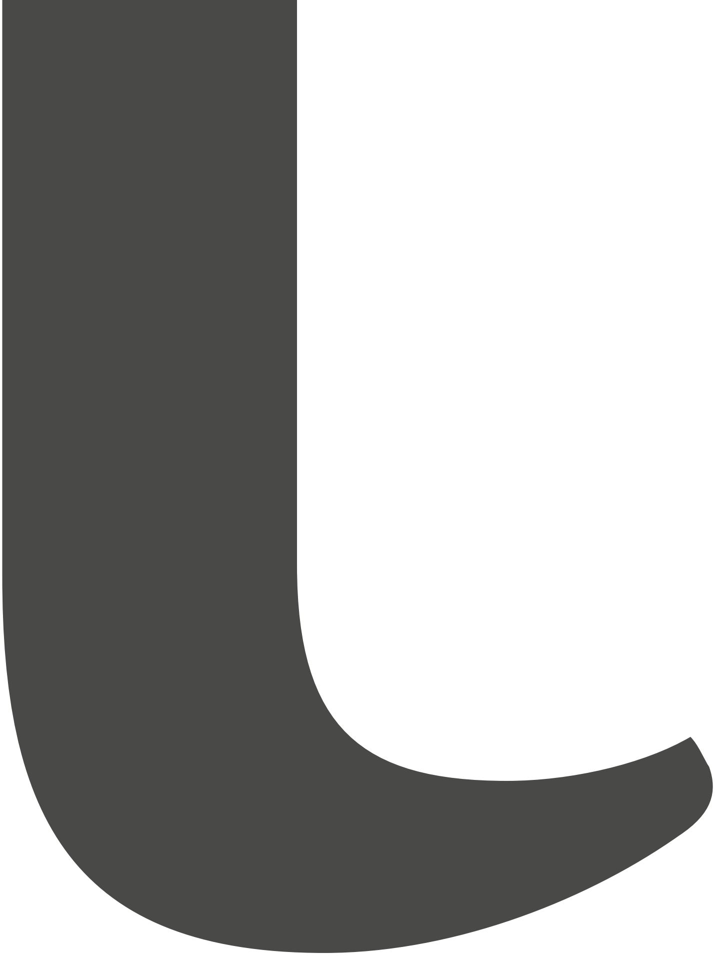
G

K

g

C

C



V

Se

in

b

p

T

fe

S

fl

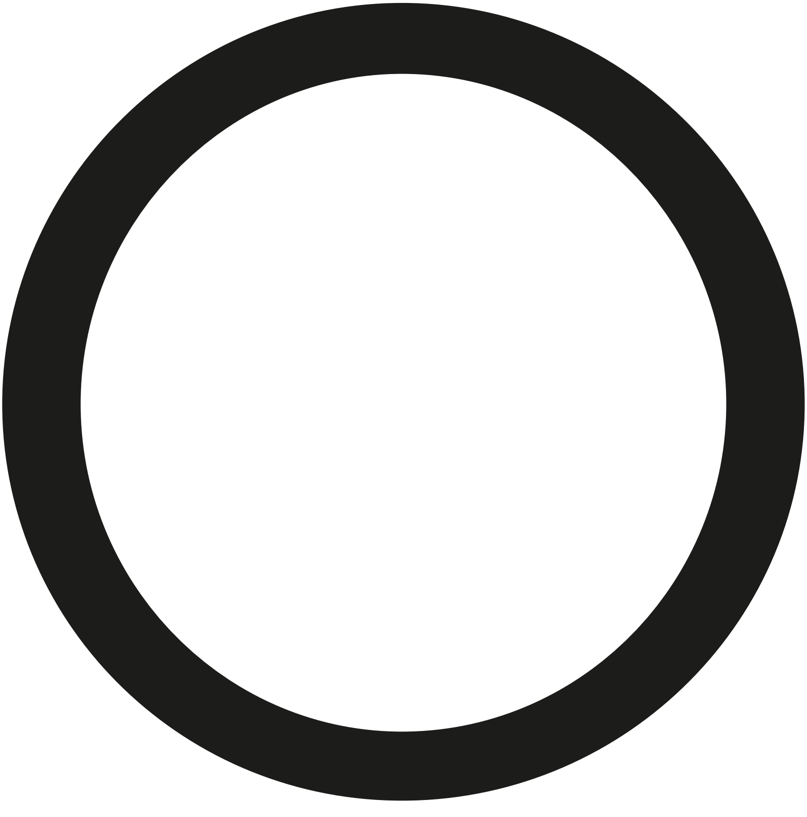
T

fl

SU

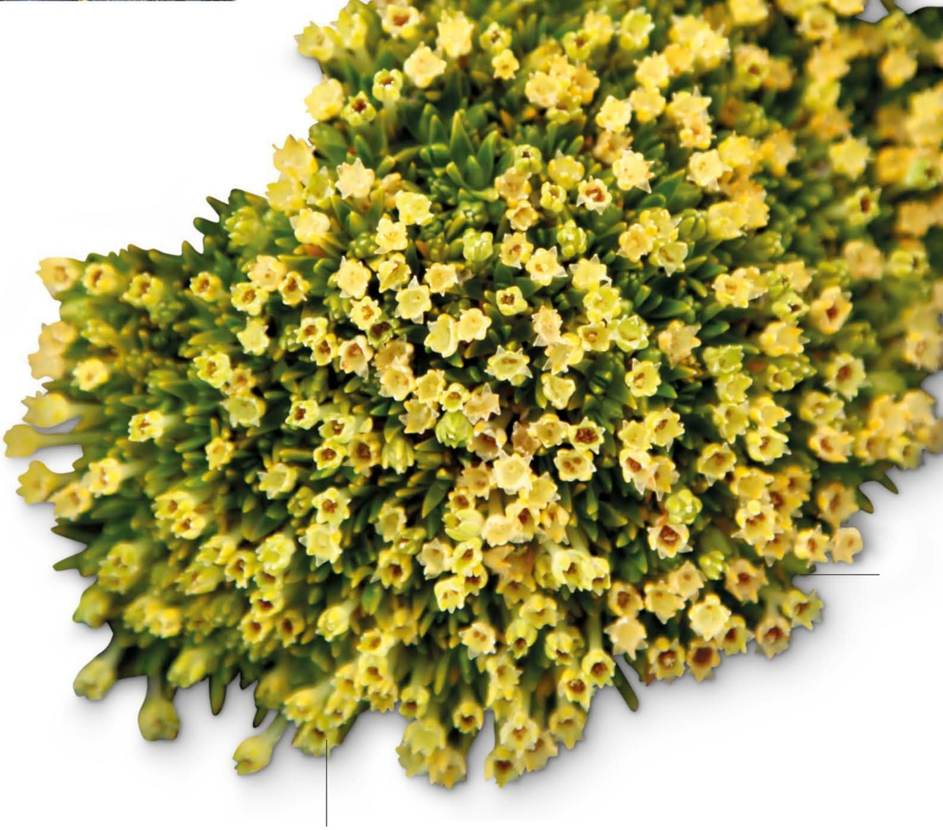
P

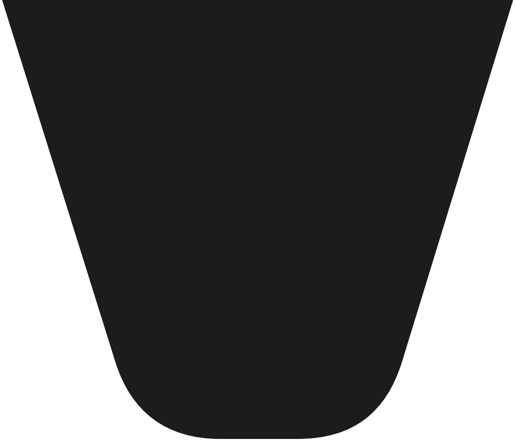
fl



it

fl





A

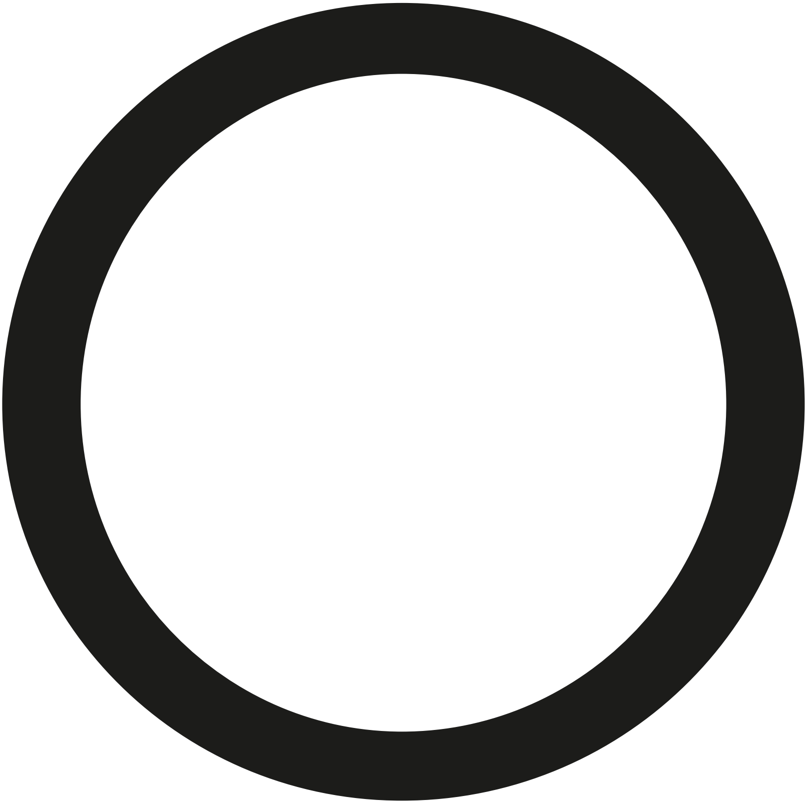
C

te

b

m

A



in

sh

th

T

sp

Si

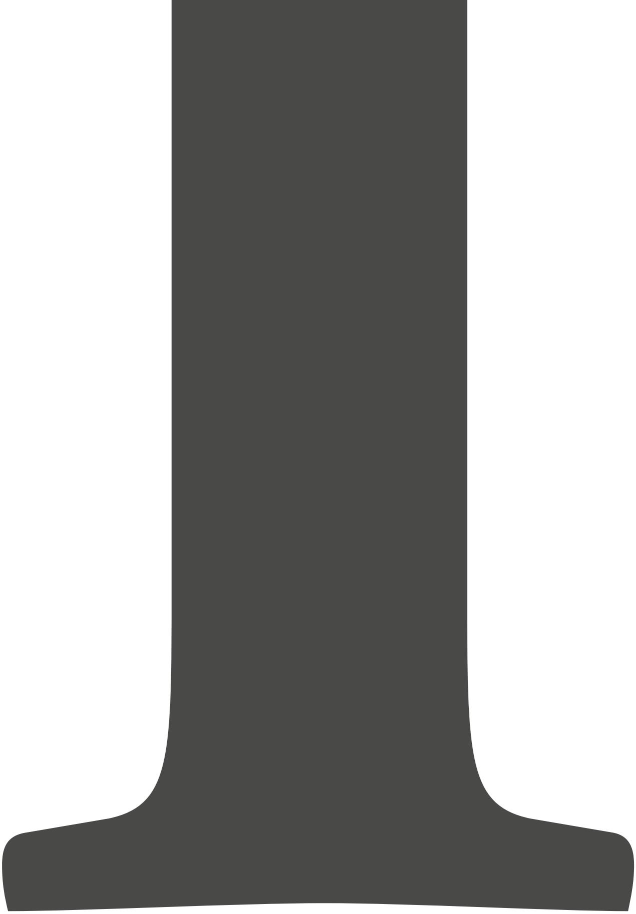
Pe

g

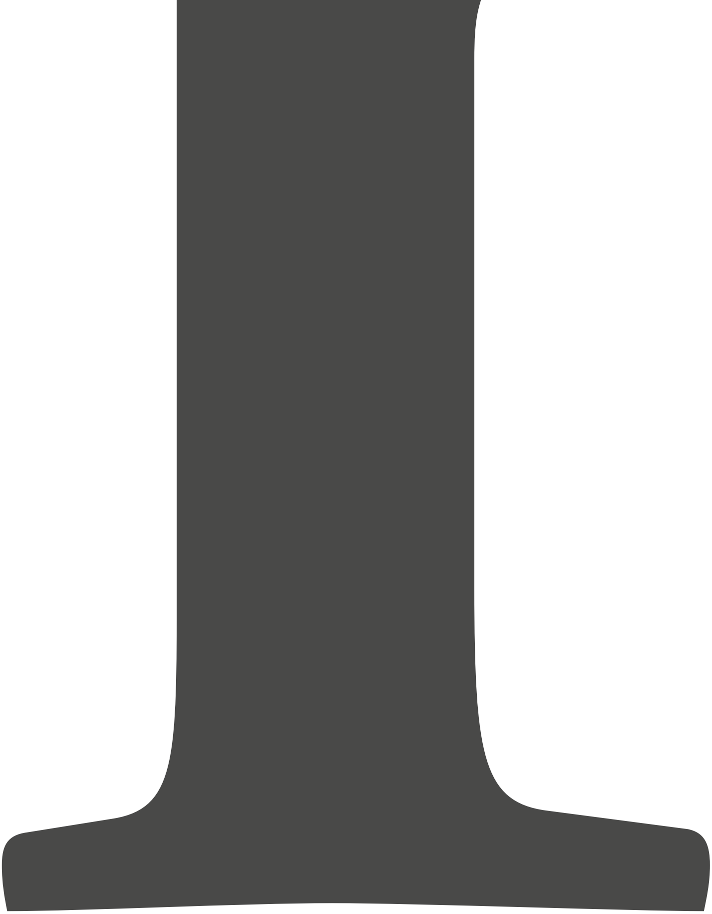
2

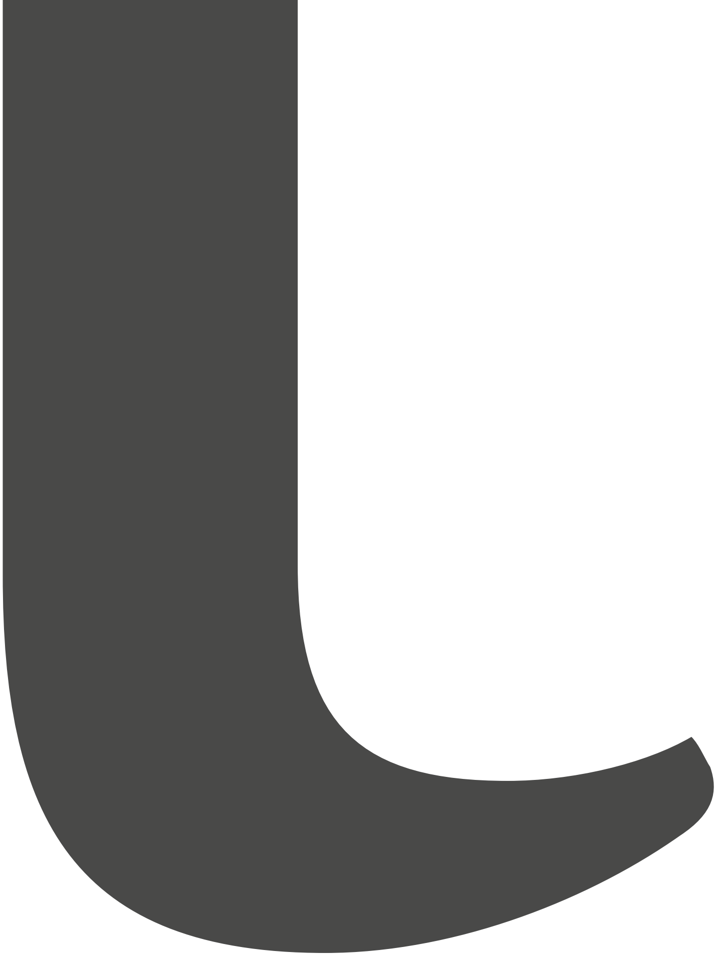
a

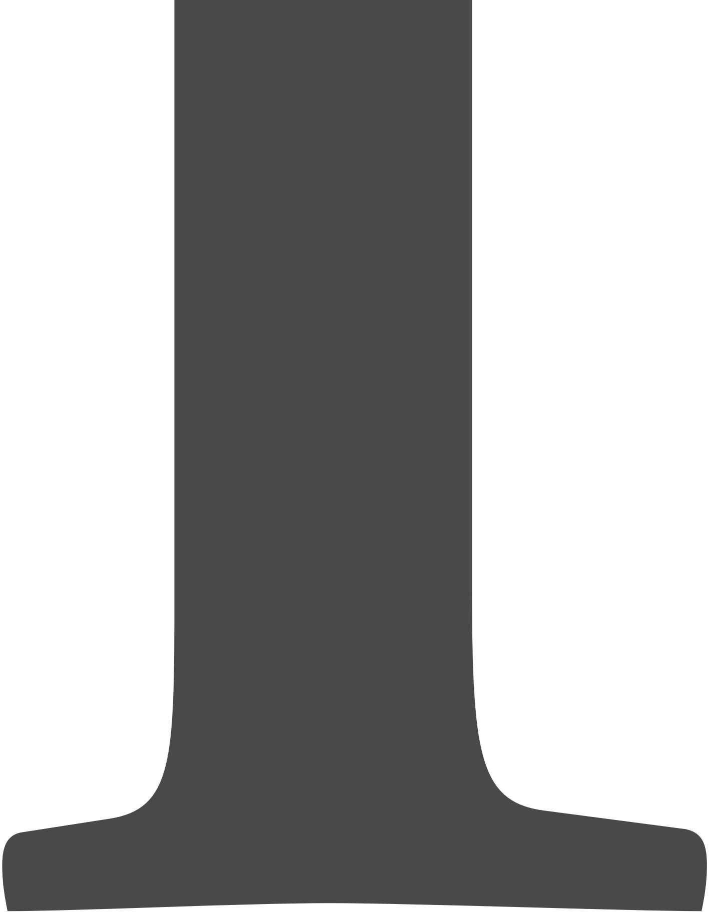
1

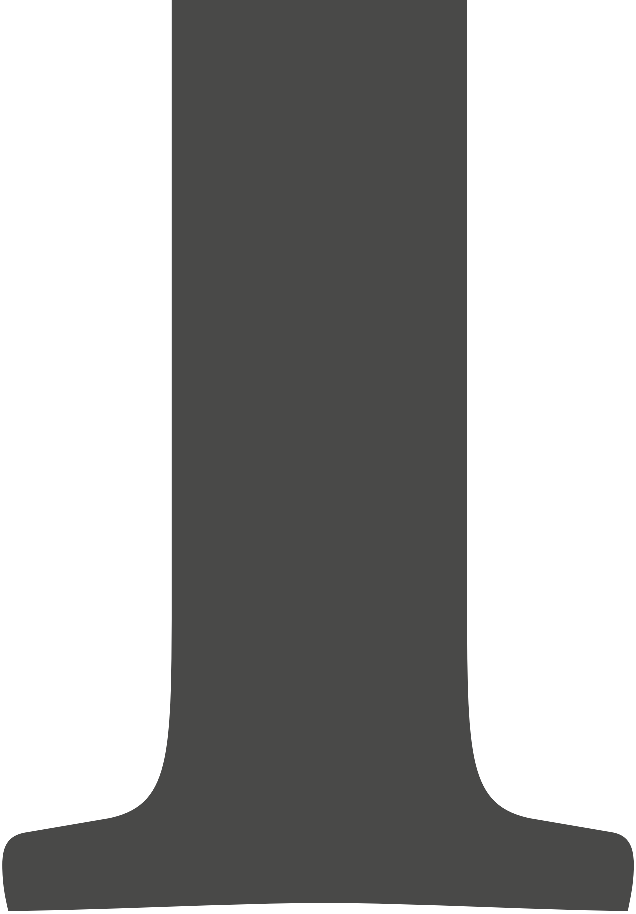


V

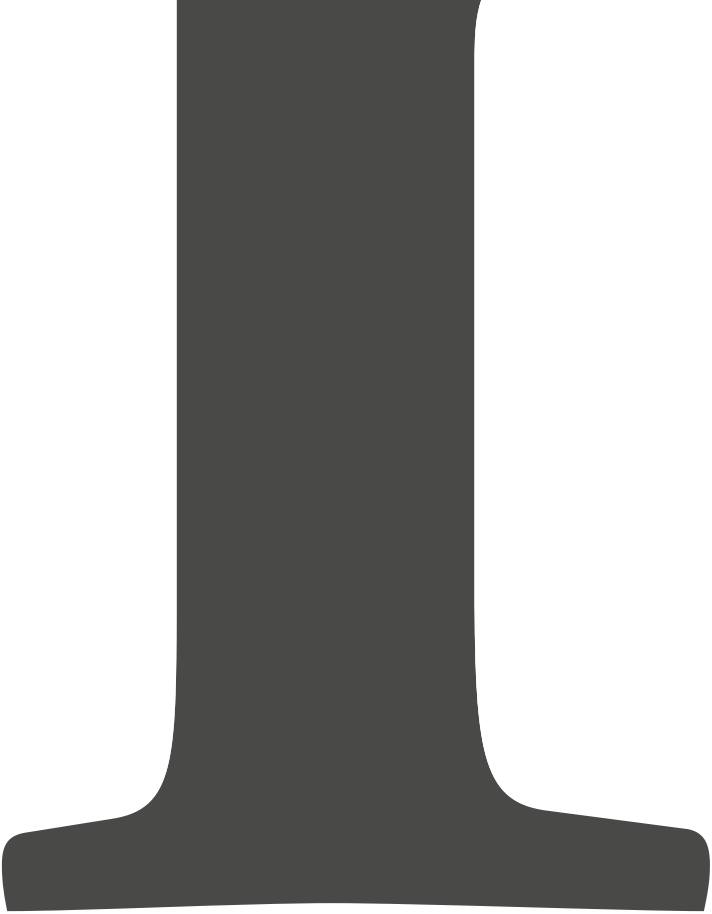




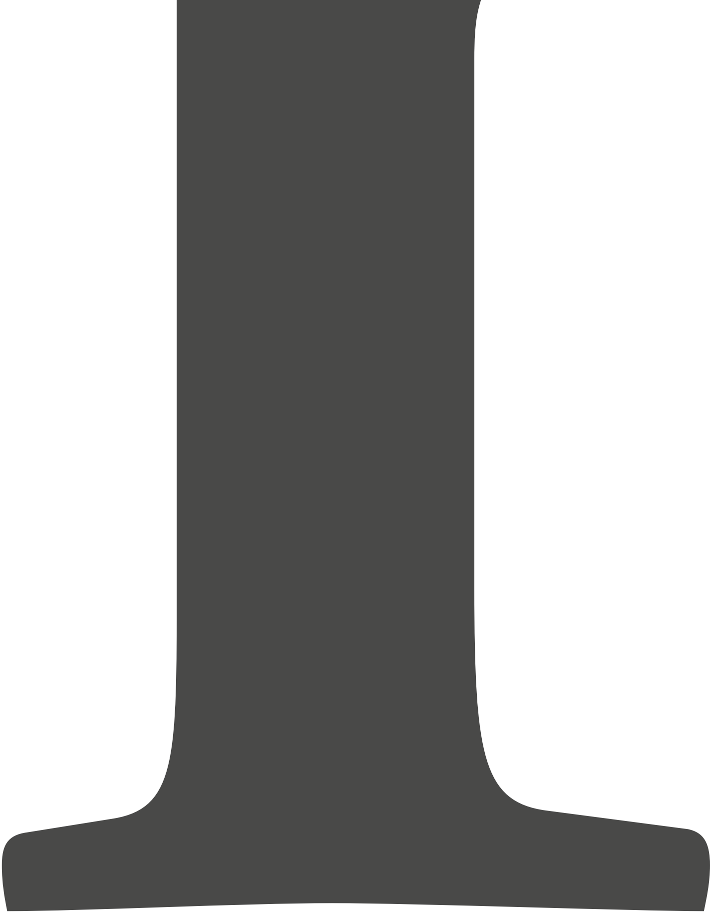


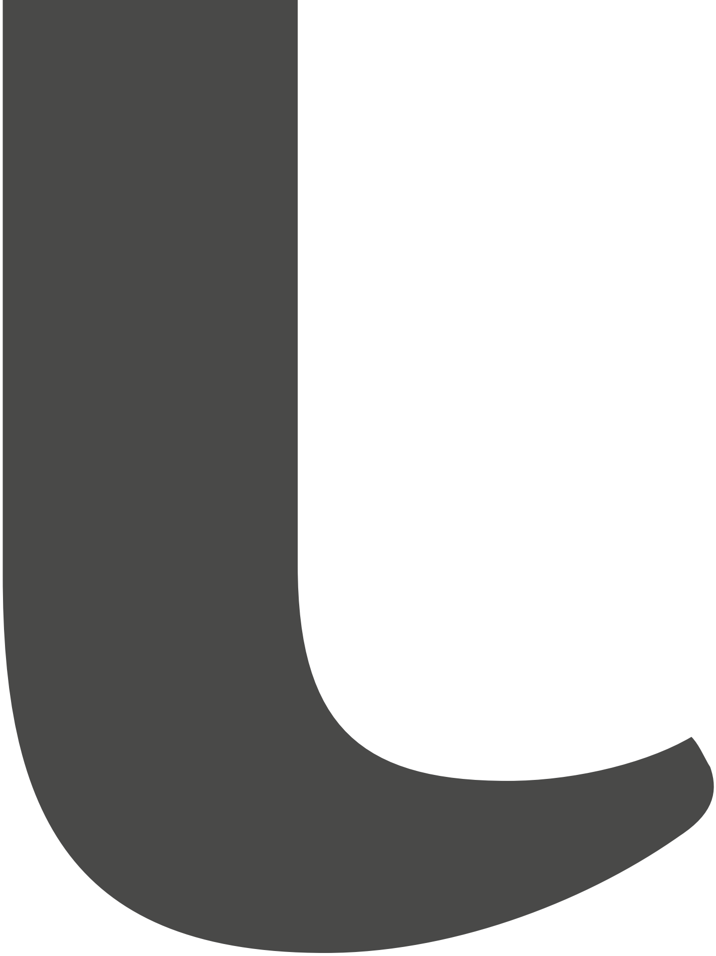


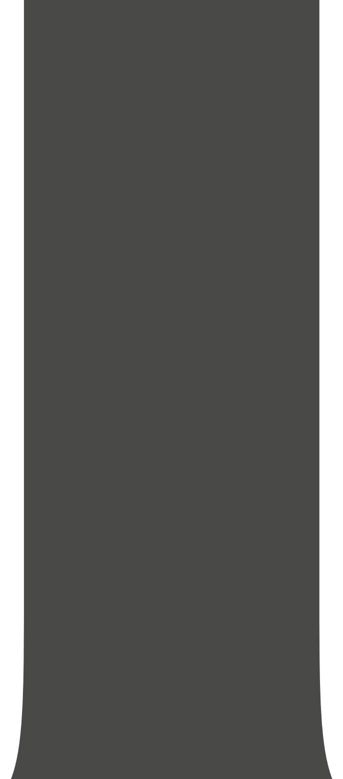
V

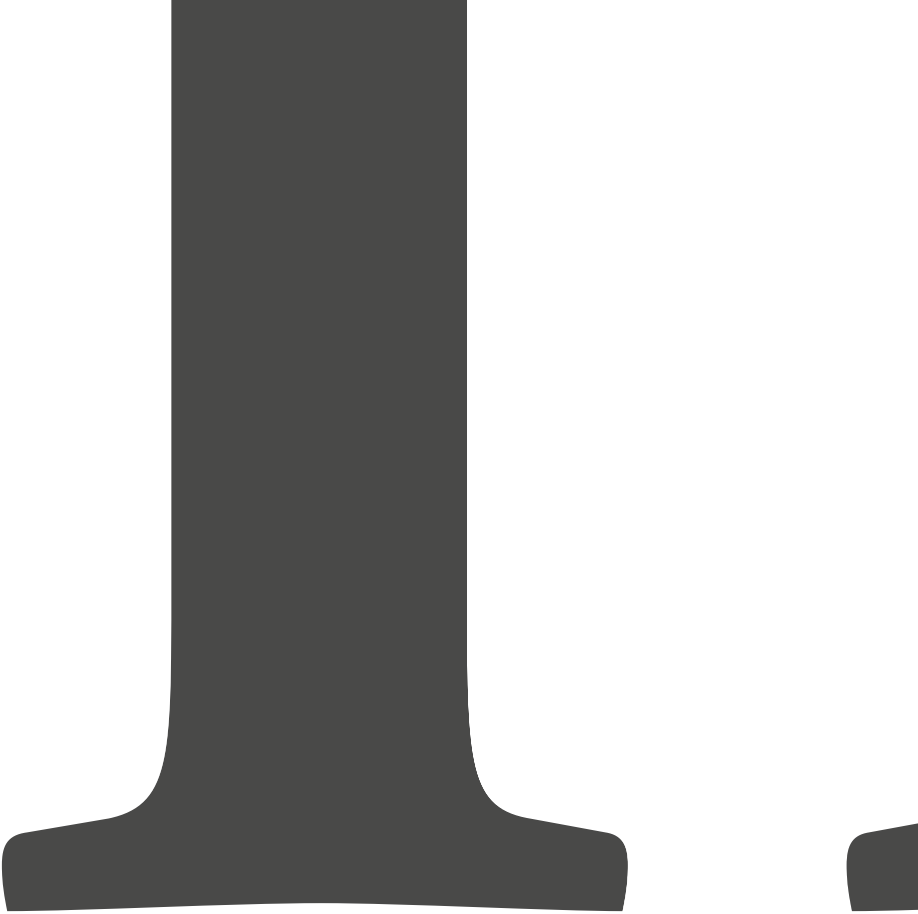


S

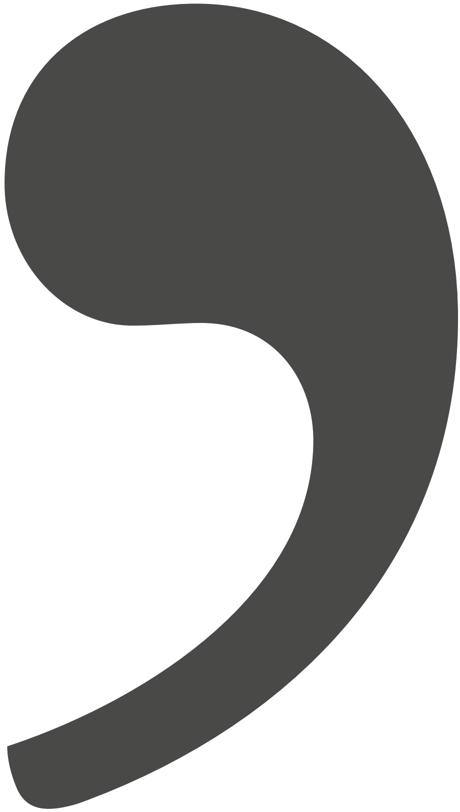




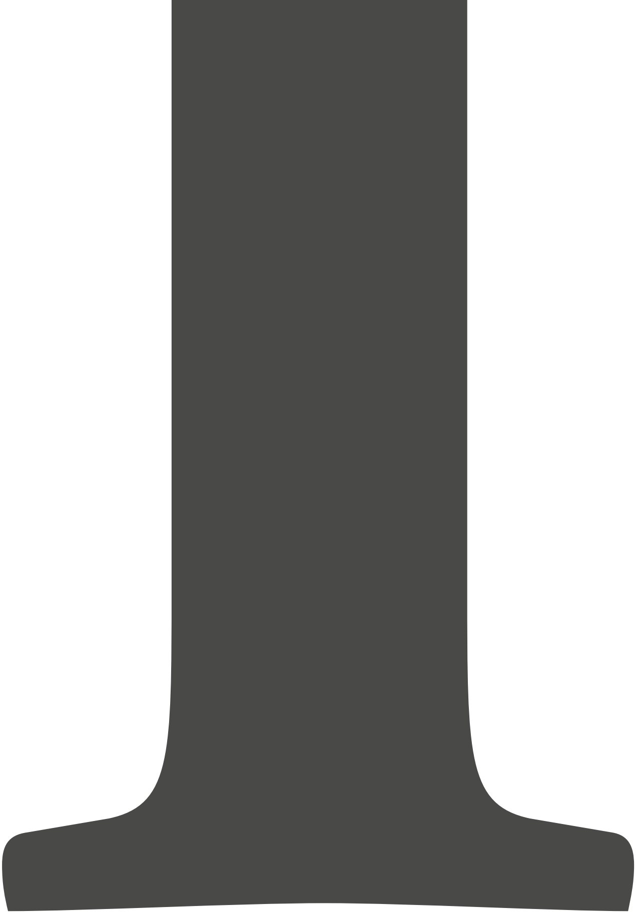




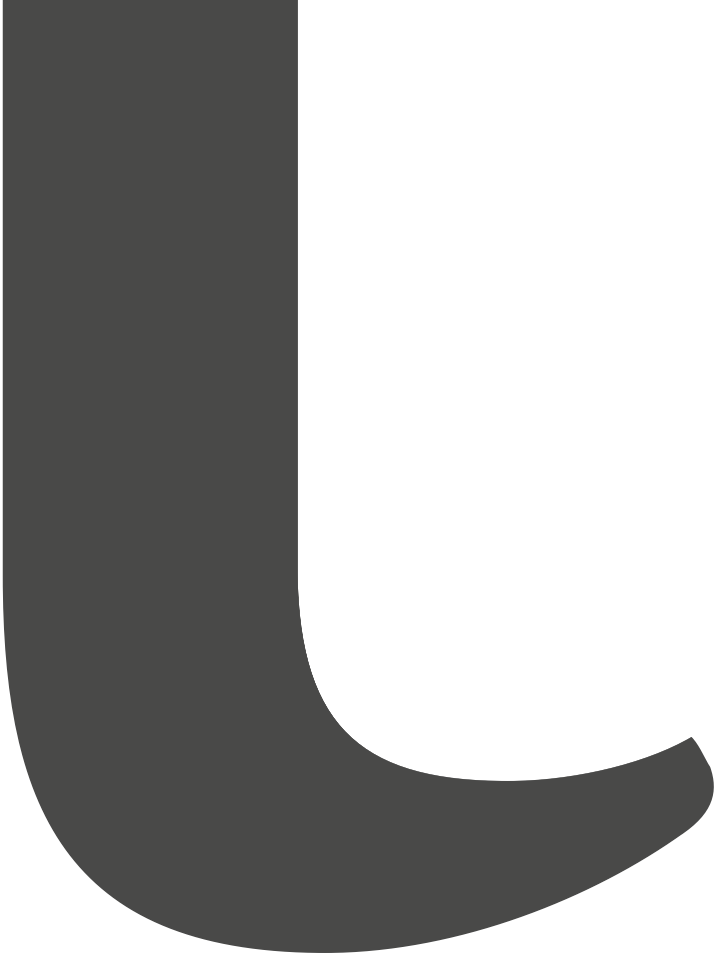
y

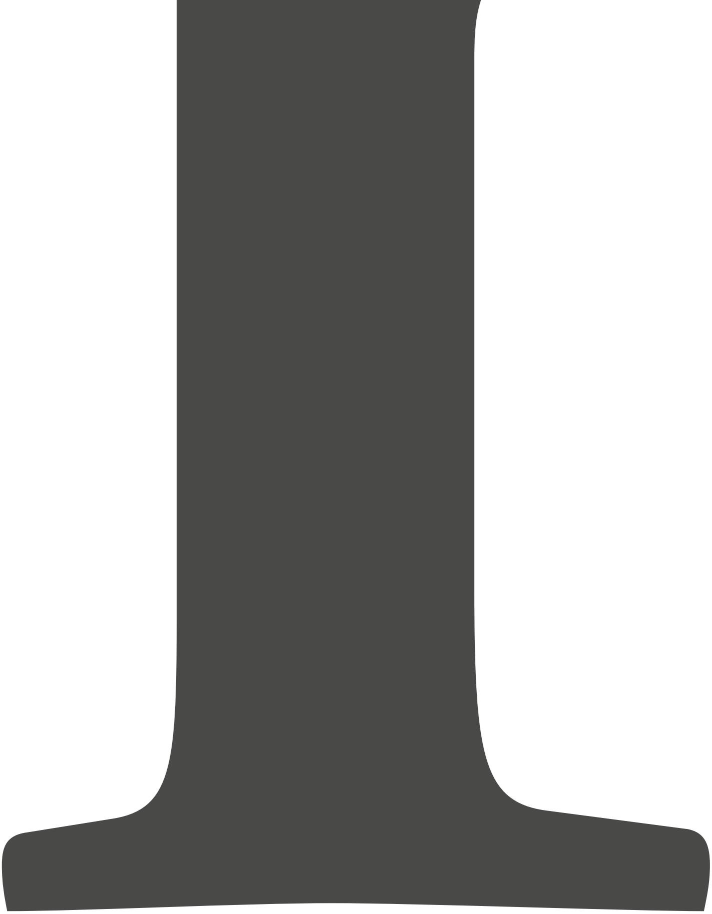


y

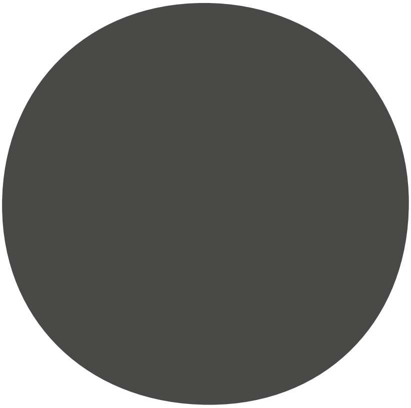


V

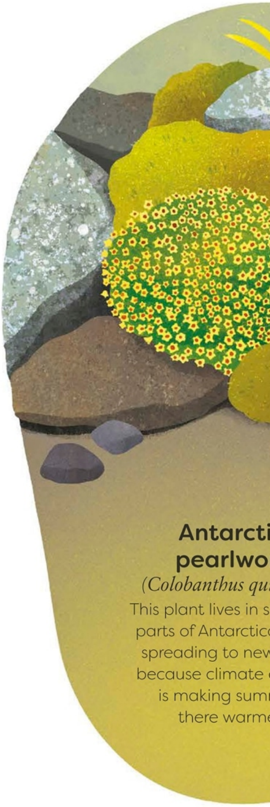




S



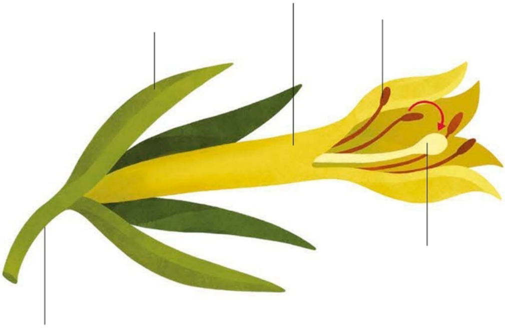
Antarctic pearlwort



Antarcti pearlwo

(Colobanthus qu

This plant lives in s
parts of Antarctic
spreading to new
because climate
is making sum
there warme



Self-pollination

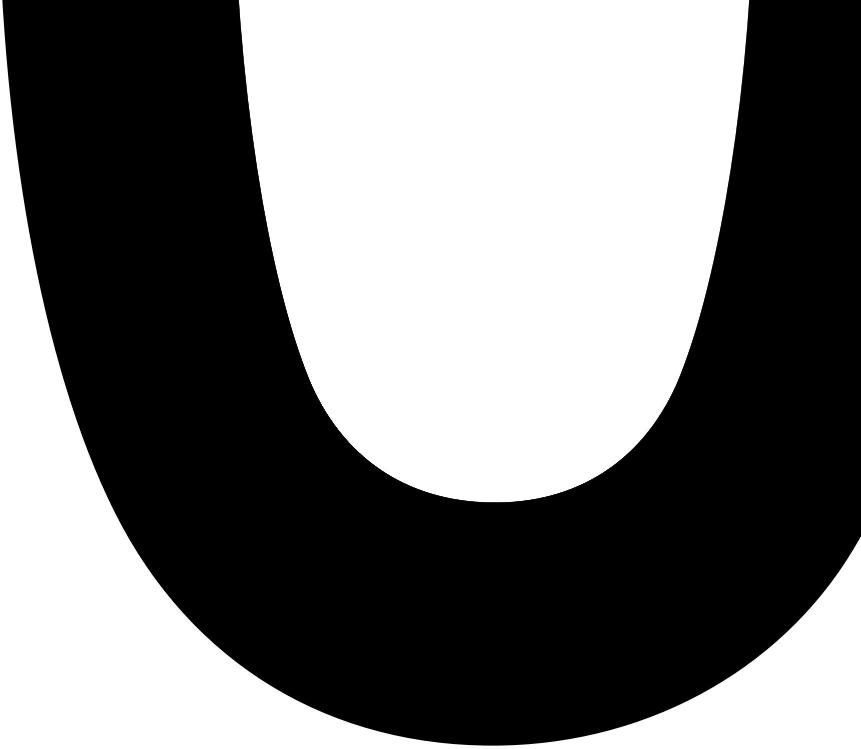
Antarctic pearlwort carries out self-pollination. This occurs when pollen from the anthers falls onto the stigma of the same flower, or reaches another flower on the same plant. Most plants try to avoid self-pollination because it means their offspring are very similar to them and may be less adaptable to changes in the environment.

[redacted]

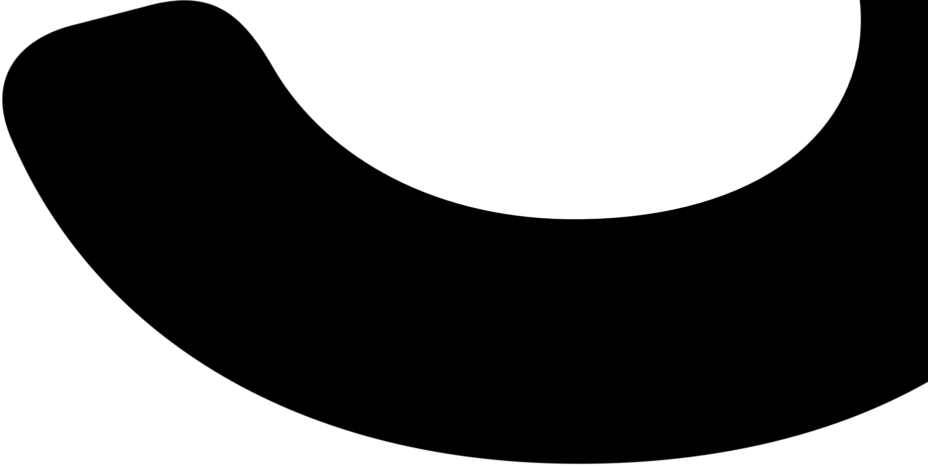
[redacted]

[redacted]

[redacted]



[redacted]



A

Se

fr

O

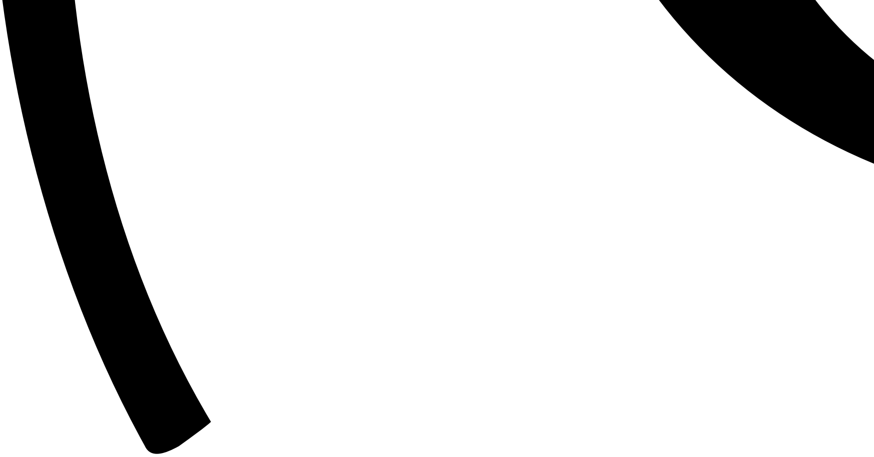
fl

tr

m

th

C



T

p

sp

b

is

th

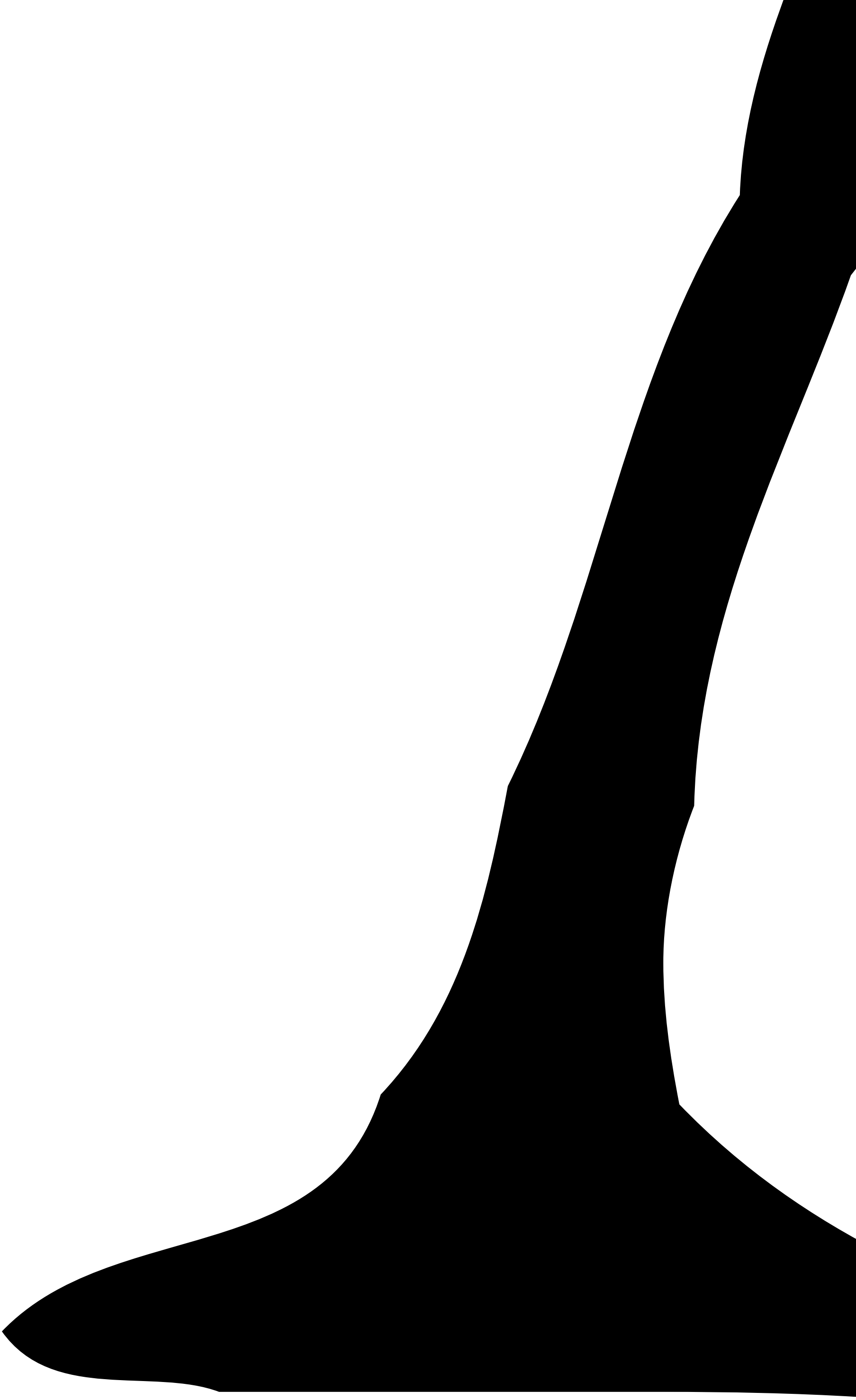
S

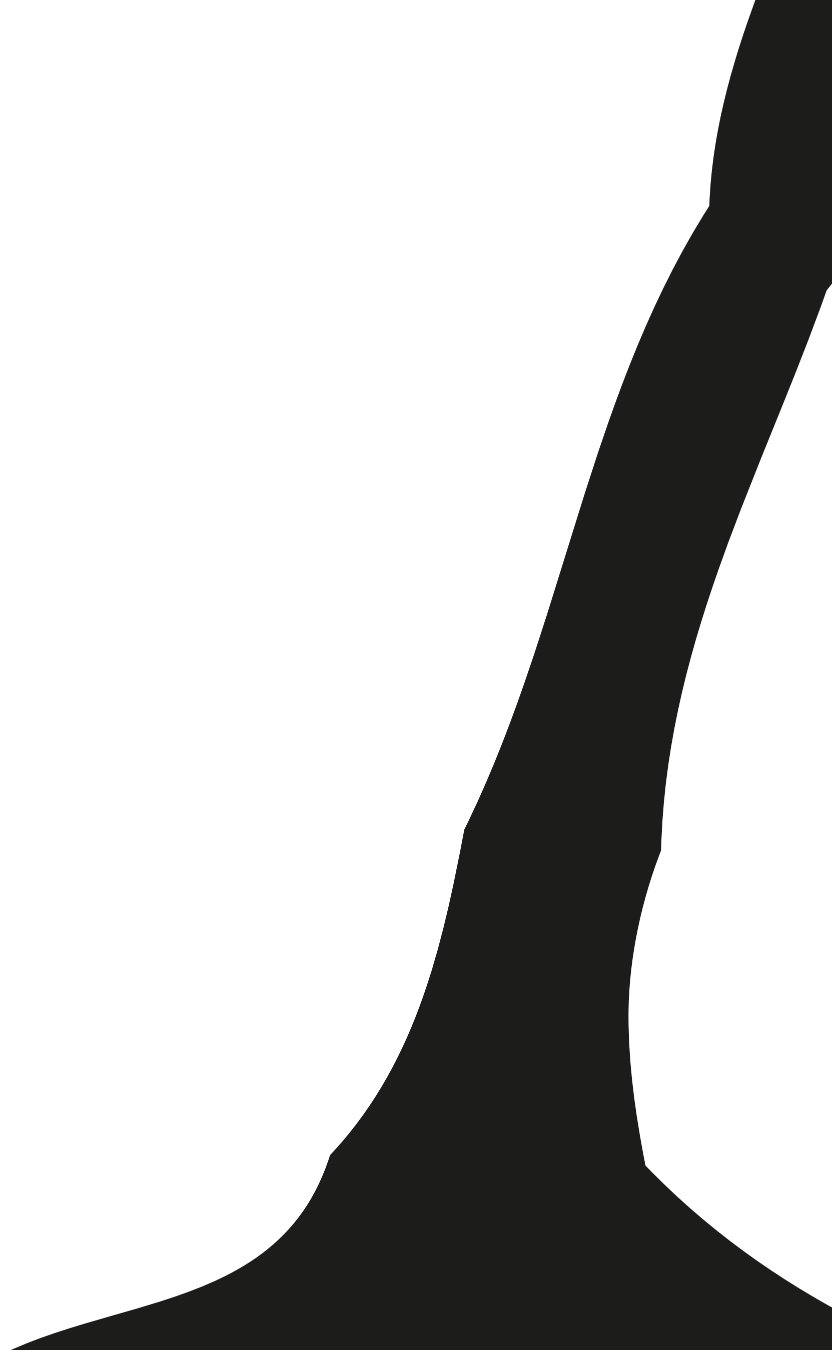
A

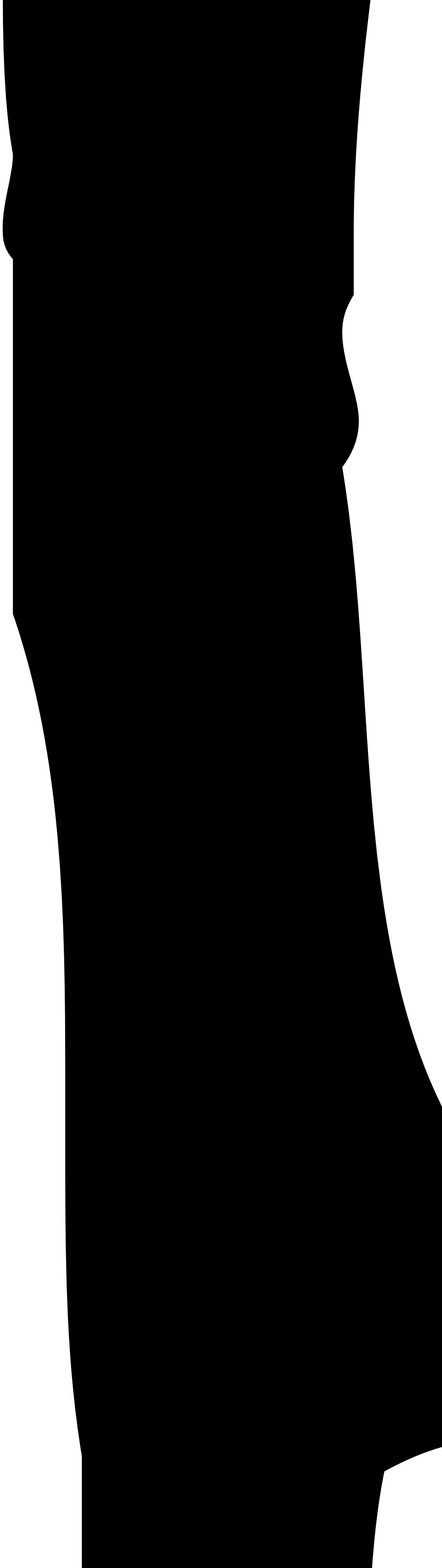
S

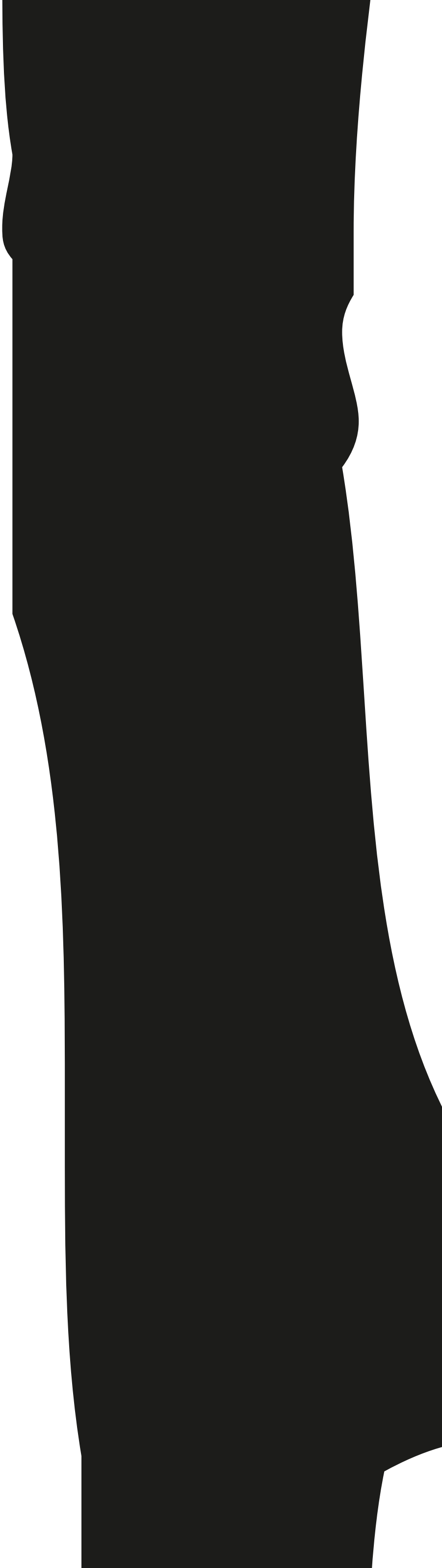
L

P

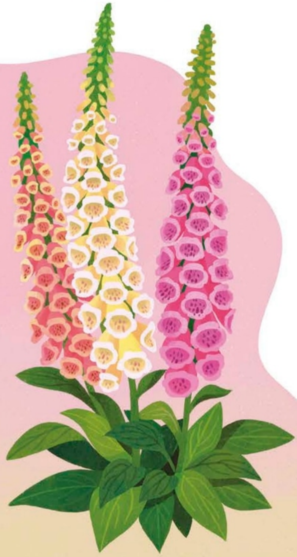








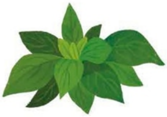
Foxglove

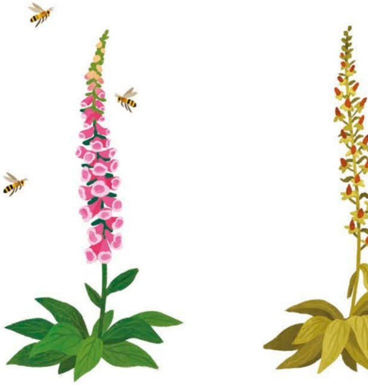


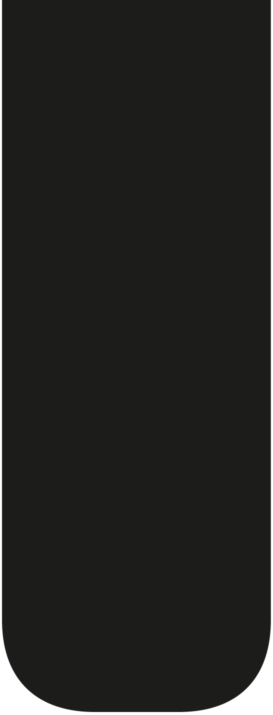
Purple foxglove
(Digitalis purpurea)
The foxglove is one of Europe's prettiest wildflowers. It lives in woods, beside roads and railroads, and on waste ground.

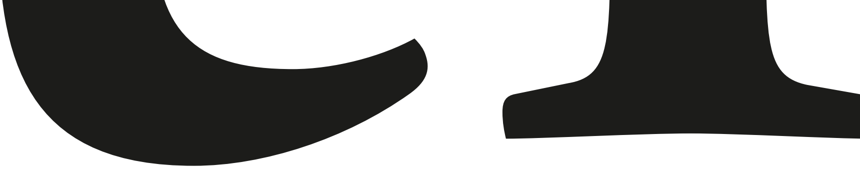
Two-year life cycle

Foxglove plants are biennials and live for just two years. They take a year to grow roots and leaves and do not bloom until the following summer. Once a foxglove's flowers have been pollinated, they develop seeds and the plant dies. The dry flowers fall off, which scatters the seeds.







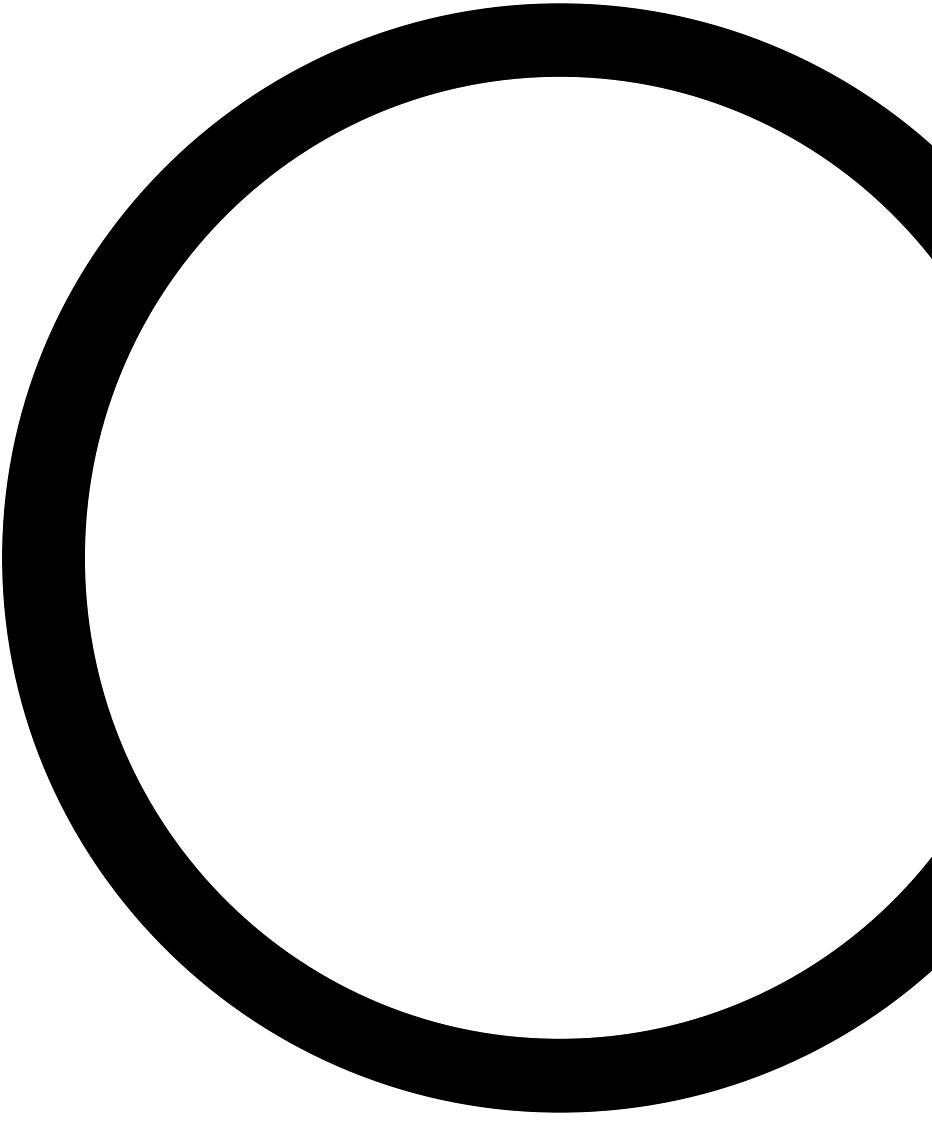


F

f

t

b



p

th

O

(

T

E

lt

r

o

Y

L

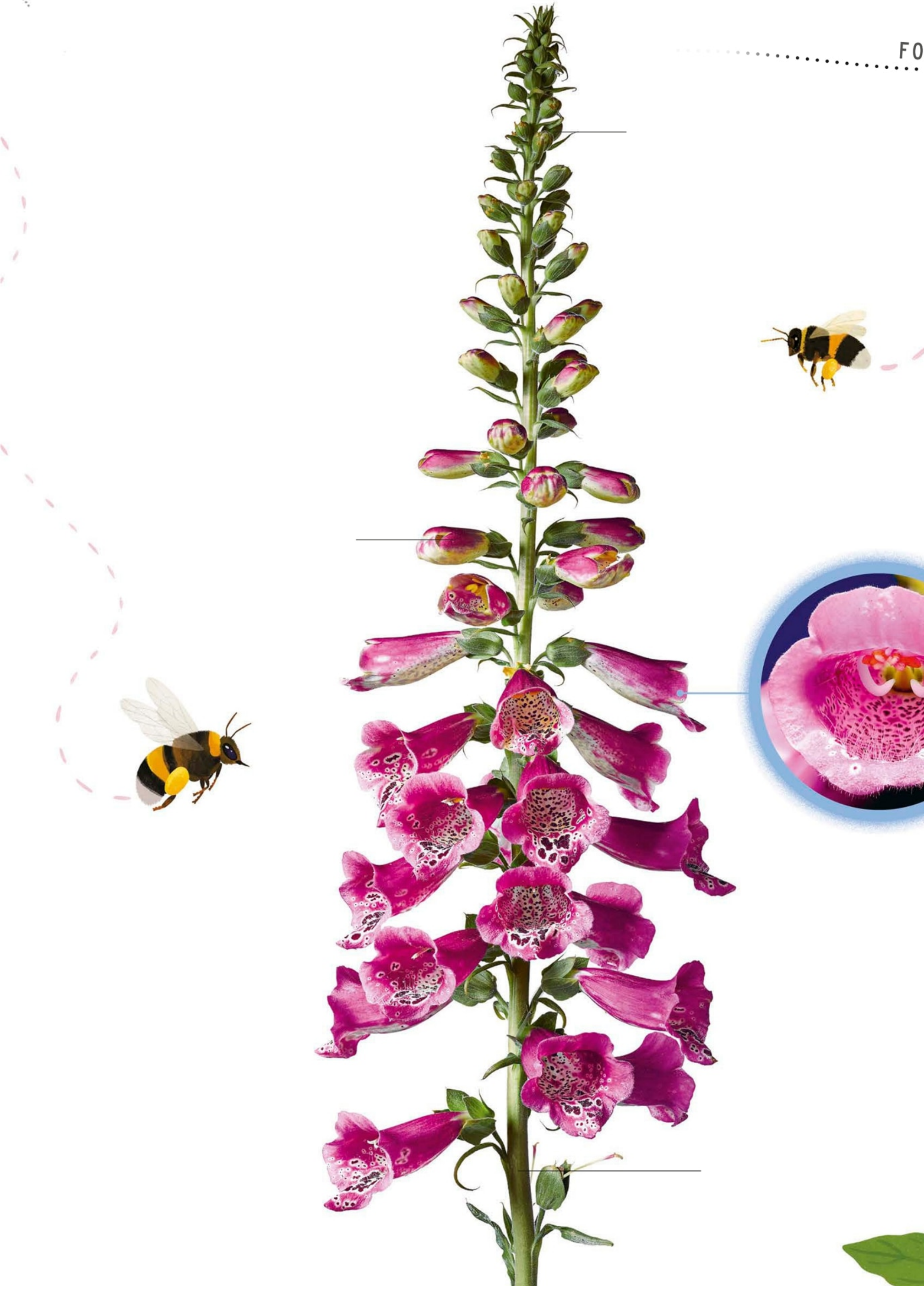
Y

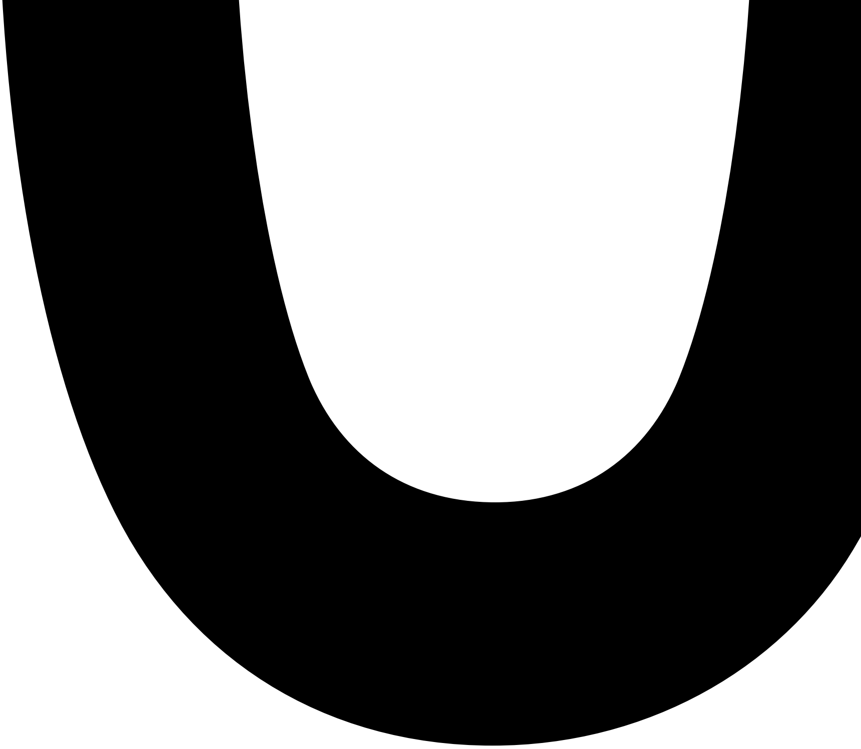
F

Y

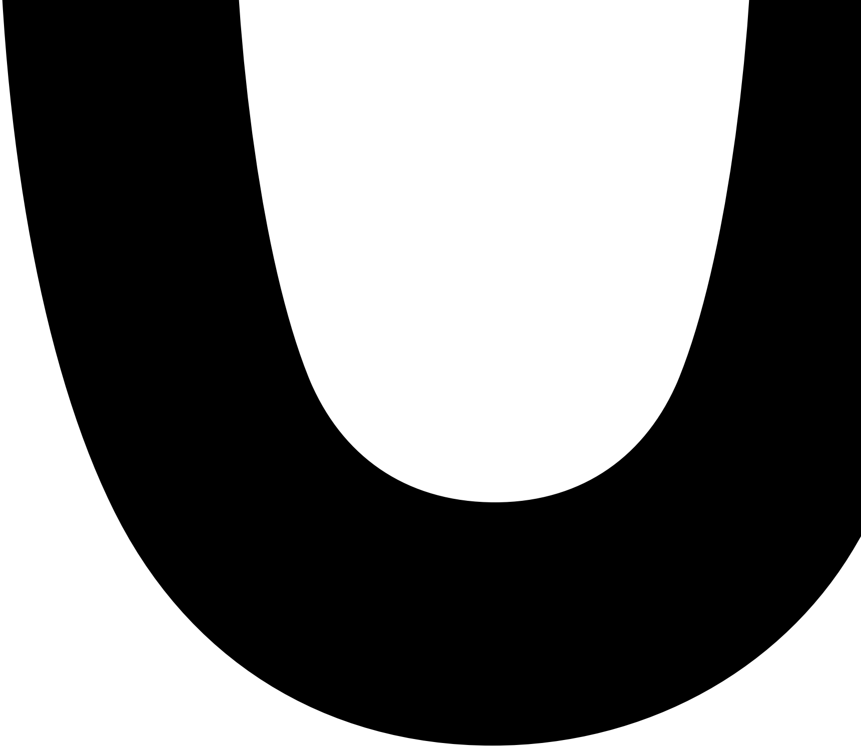
S

FO

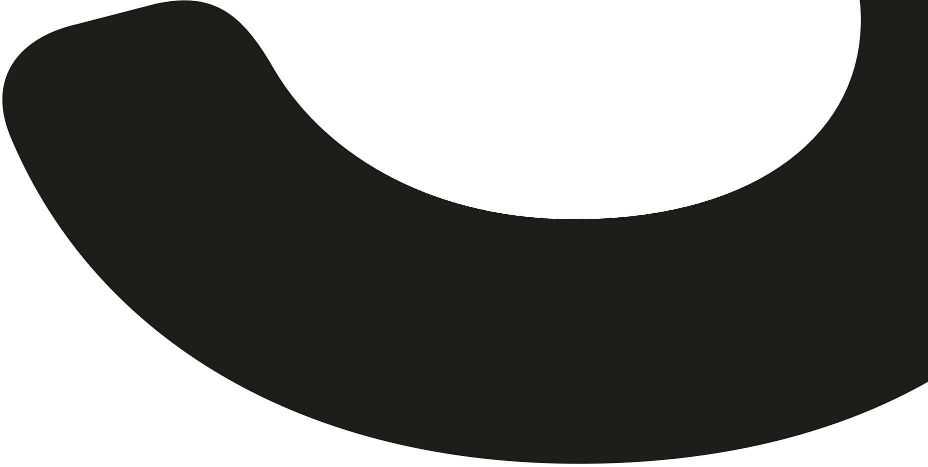




G



V



T

in

C

a

th

S

E

O

A

a

T

th

a

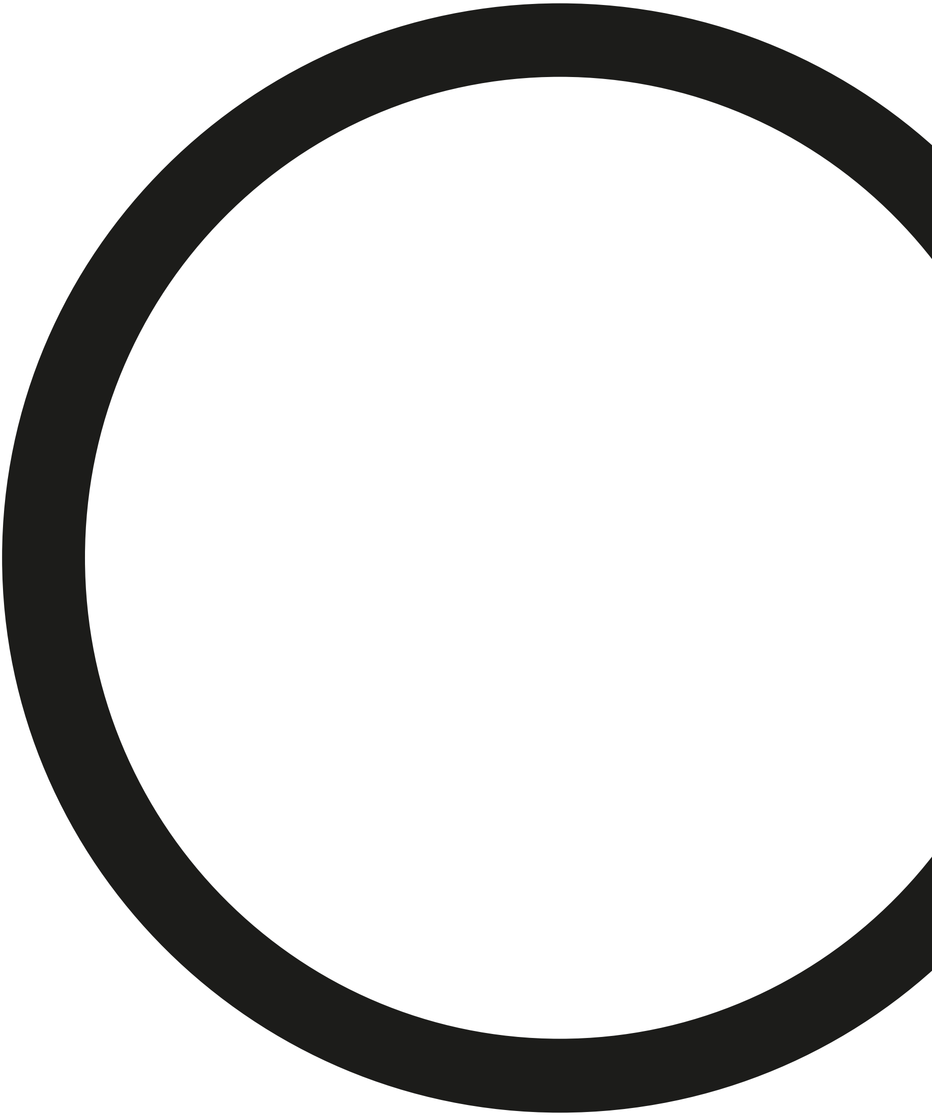
W

us

O

C

1

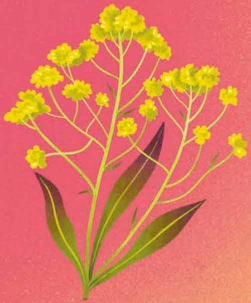


C

b

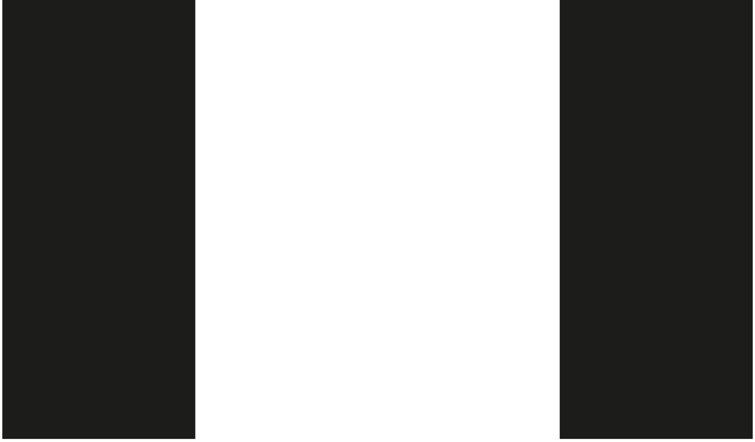
fl

a



Natural or artificial?

Gathering wild plants can be expensive and may harm the environment, so we sometimes use alternatives. The leaves of woad, for example, were collected to extract a blue dye, but we can now make artificial dye in laboratories.



A

h

ke

C

in

i

F

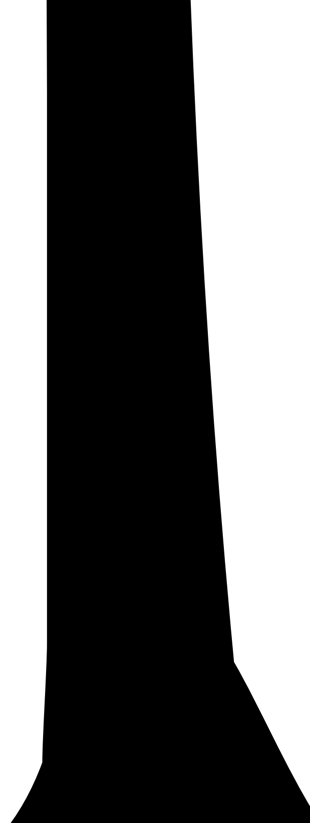
th

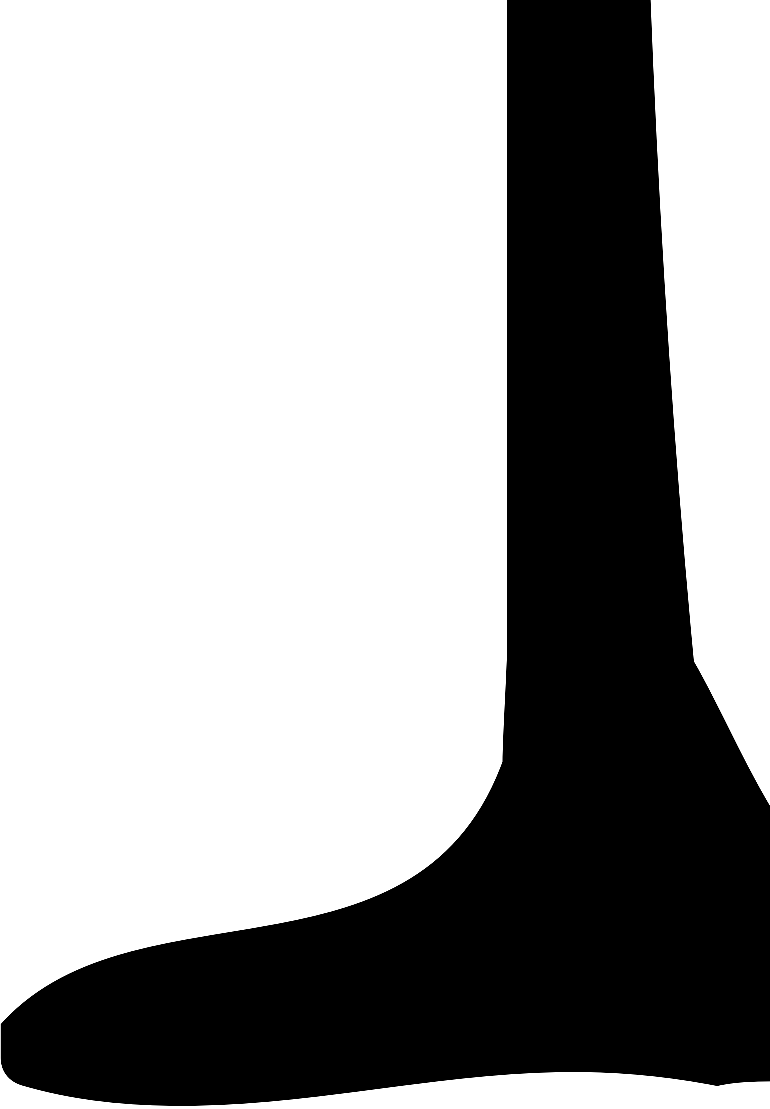
a

re

is

D





"

L

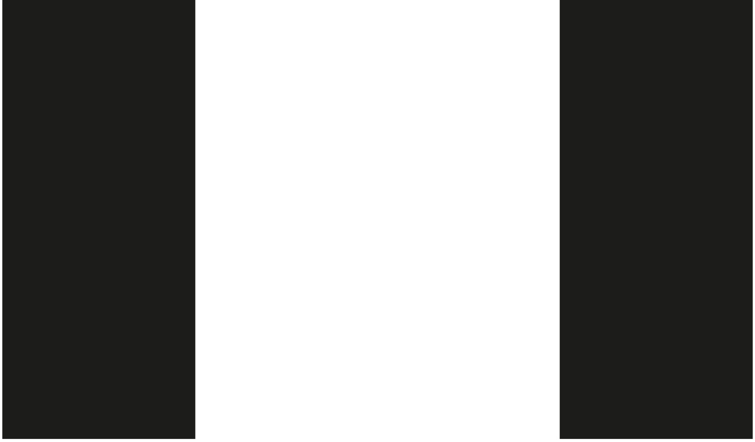
h

fr

A

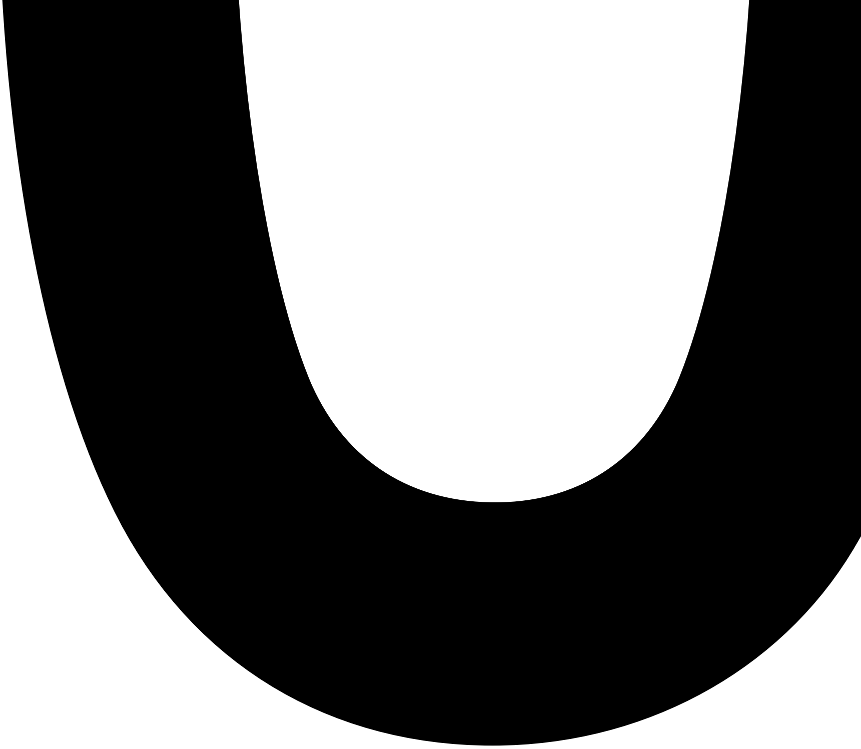
le

Plant products



[redacted]

[redacted]



U

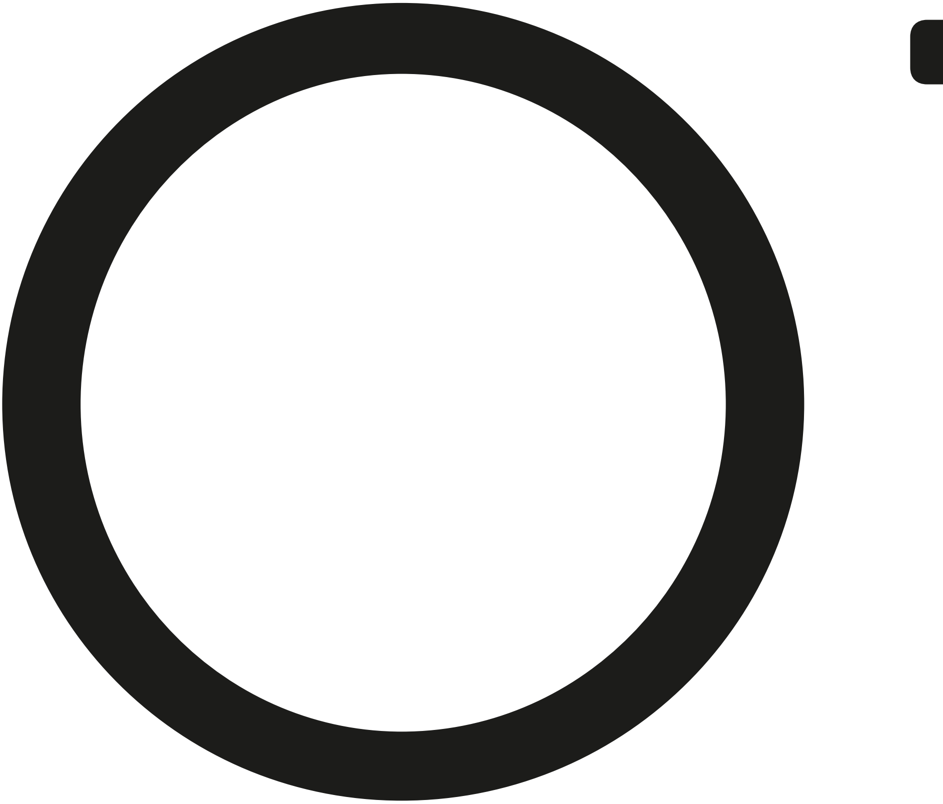
[redacted]

L

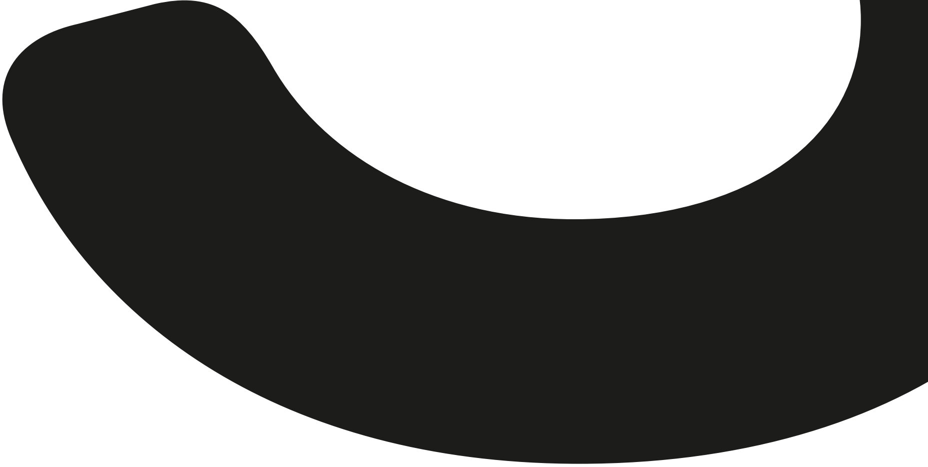
m

re

p



H



T

S

in

p

f

S

P

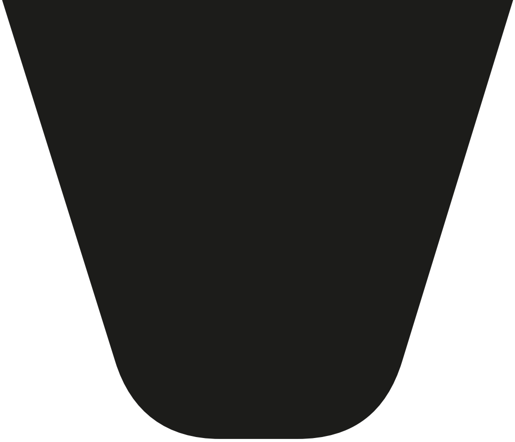
C

a

it

l

th



In

iS

g

m

C

p

T

it

W

fi

t

b

T

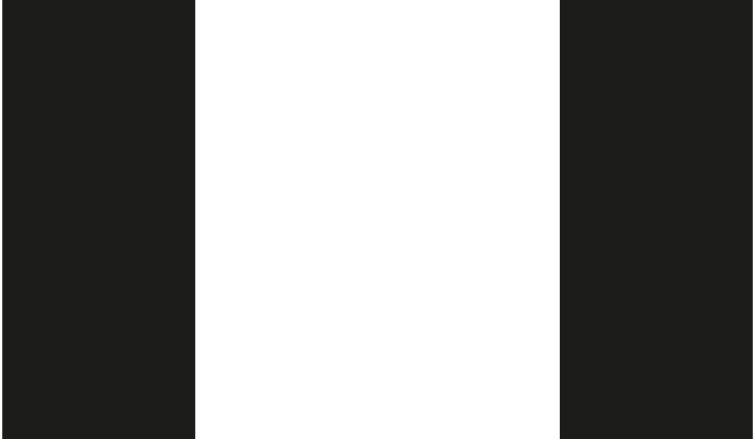
A

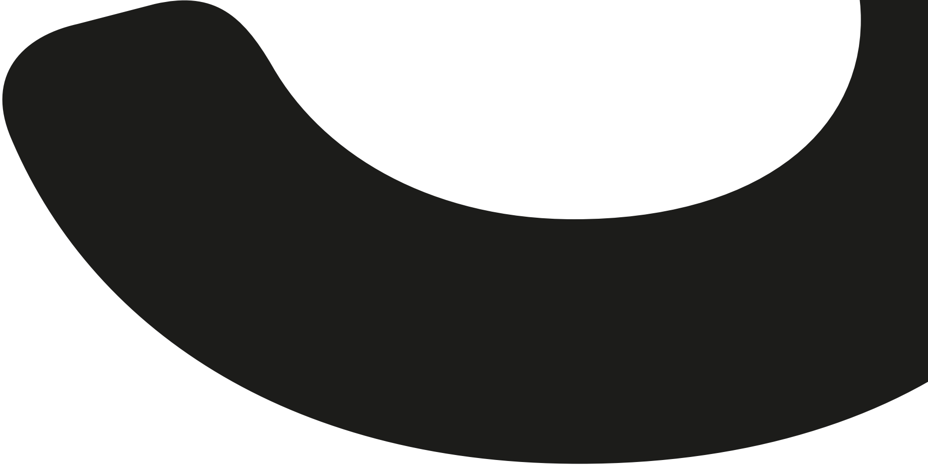
w

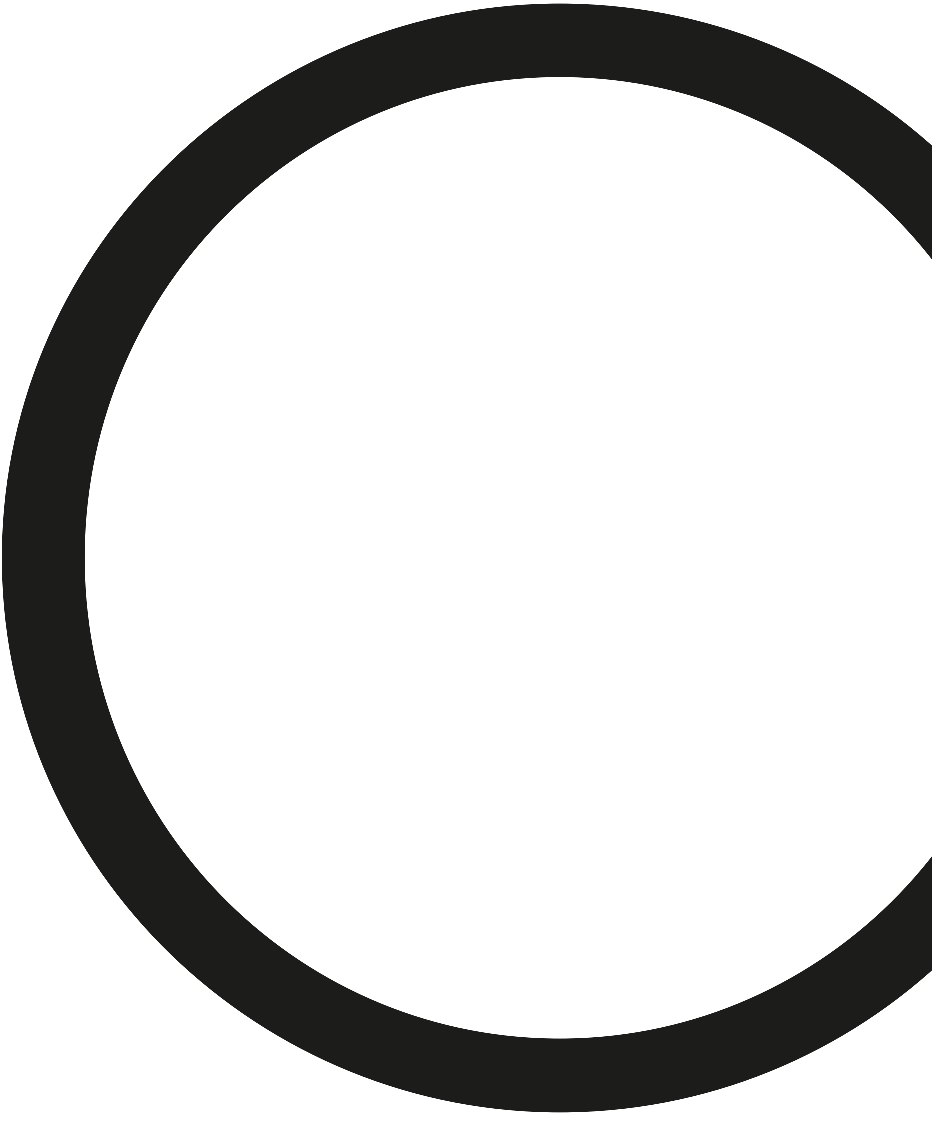
C

m

Sk







th

W

t

a

th

Se

CU

fo

T

m

C

of

L

b

a

th

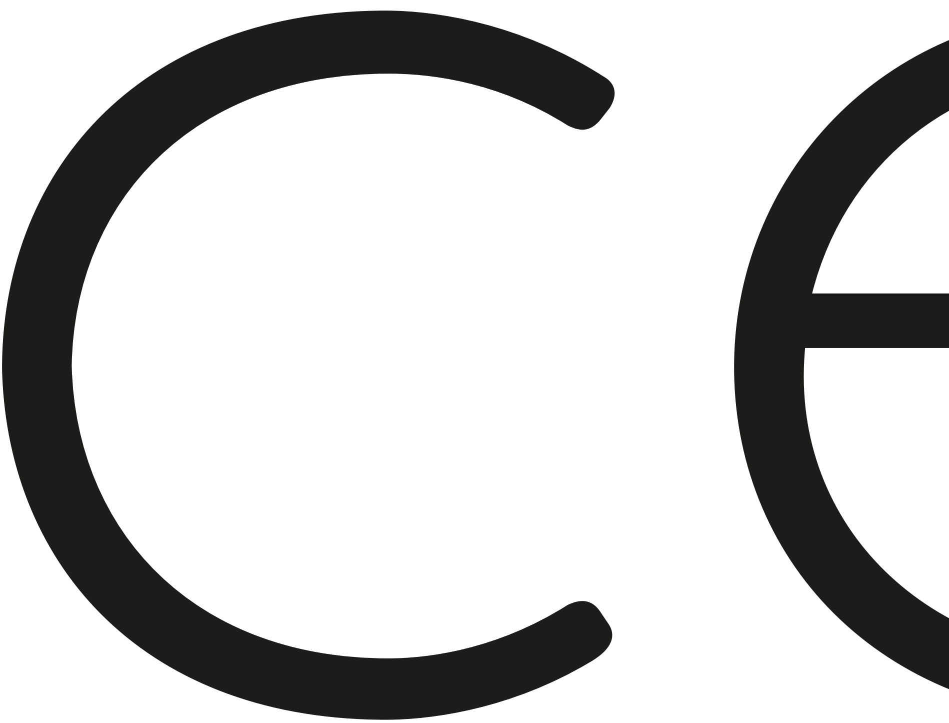
le

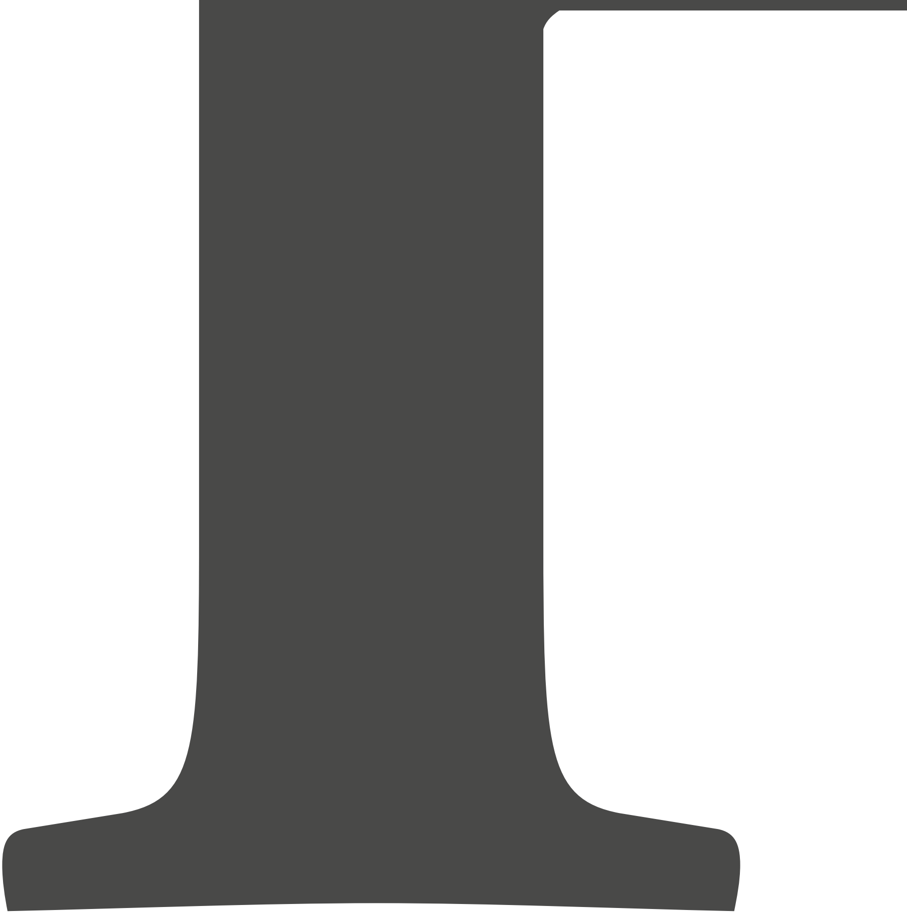
a

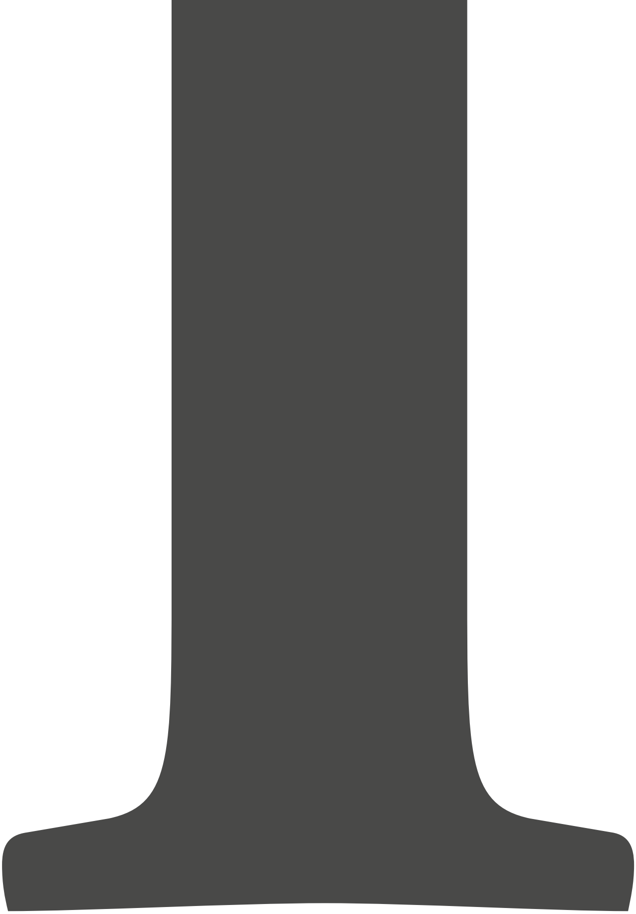
L

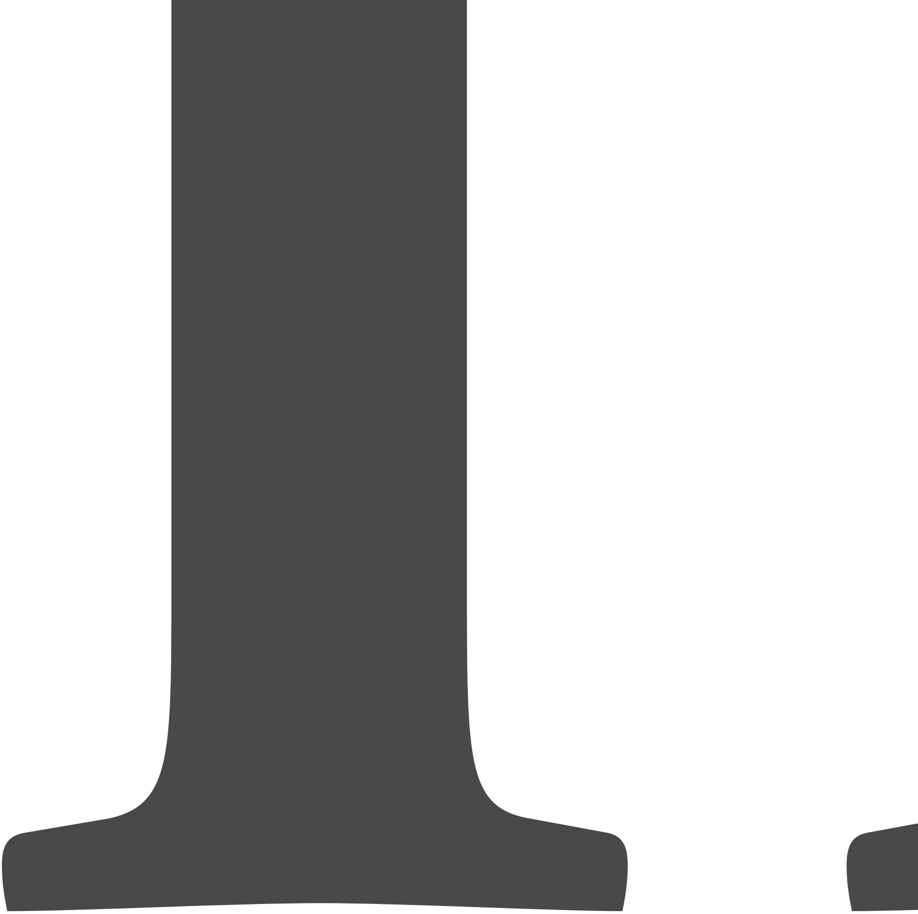
b

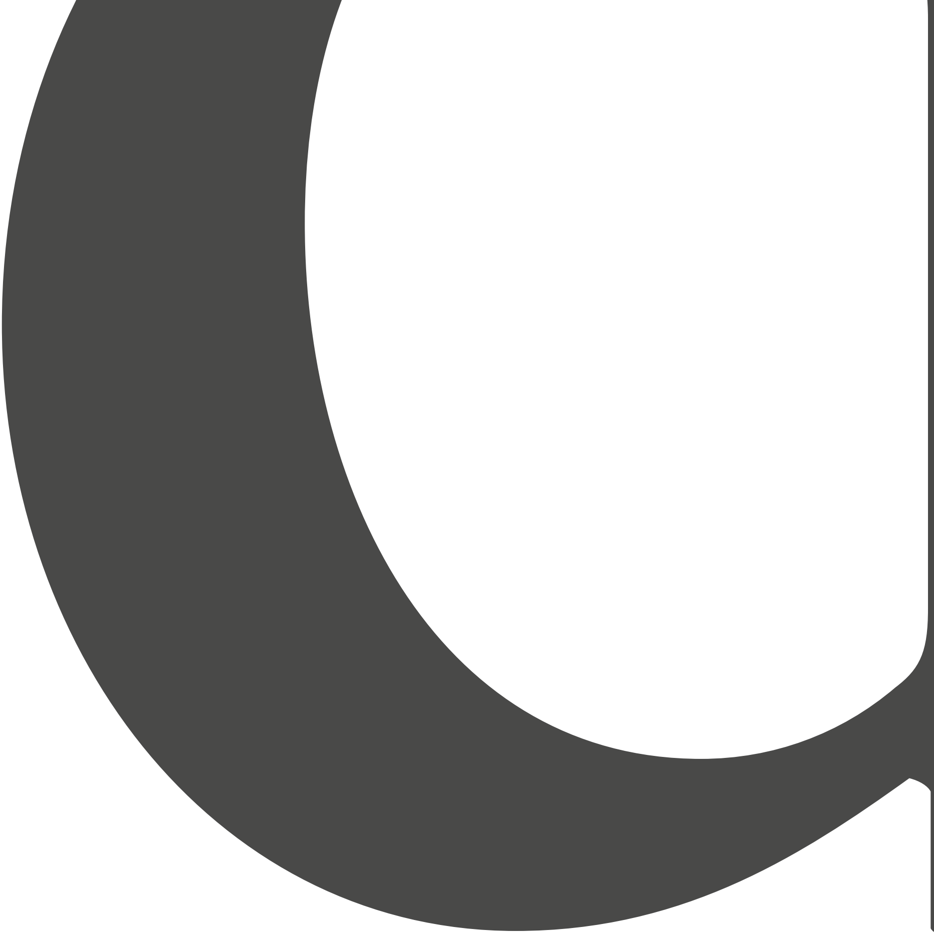
W



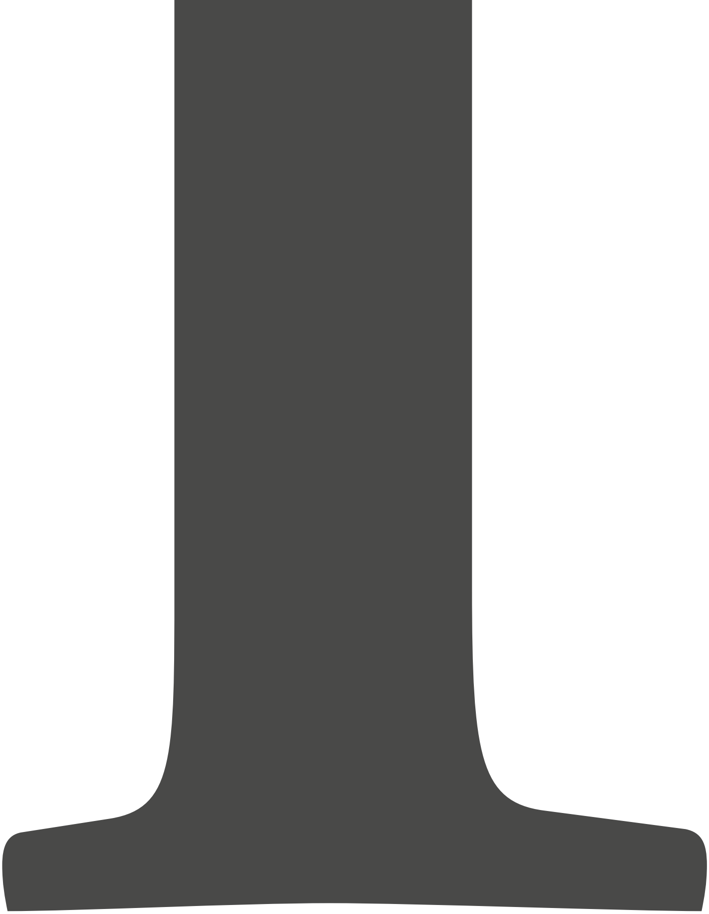


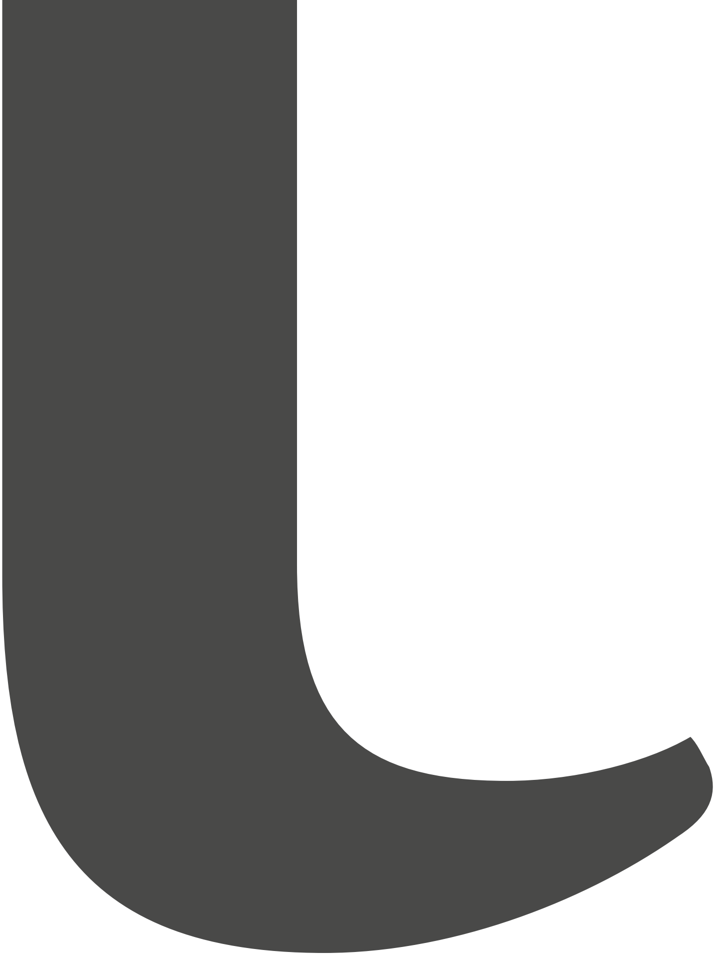


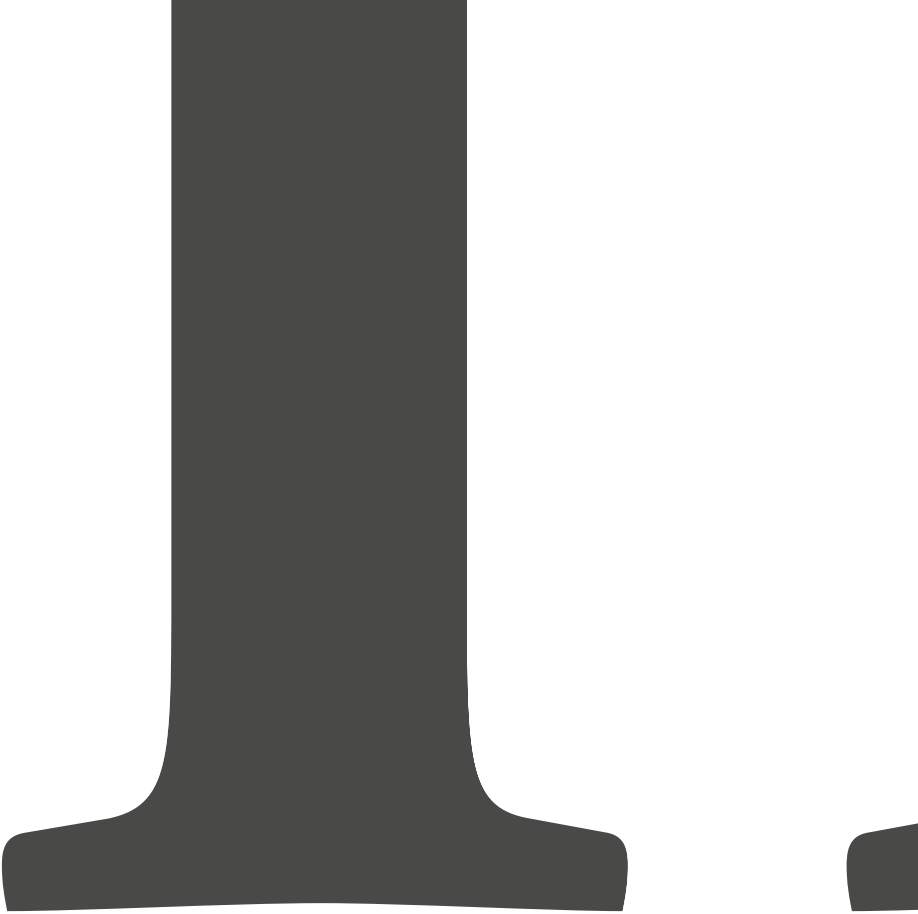


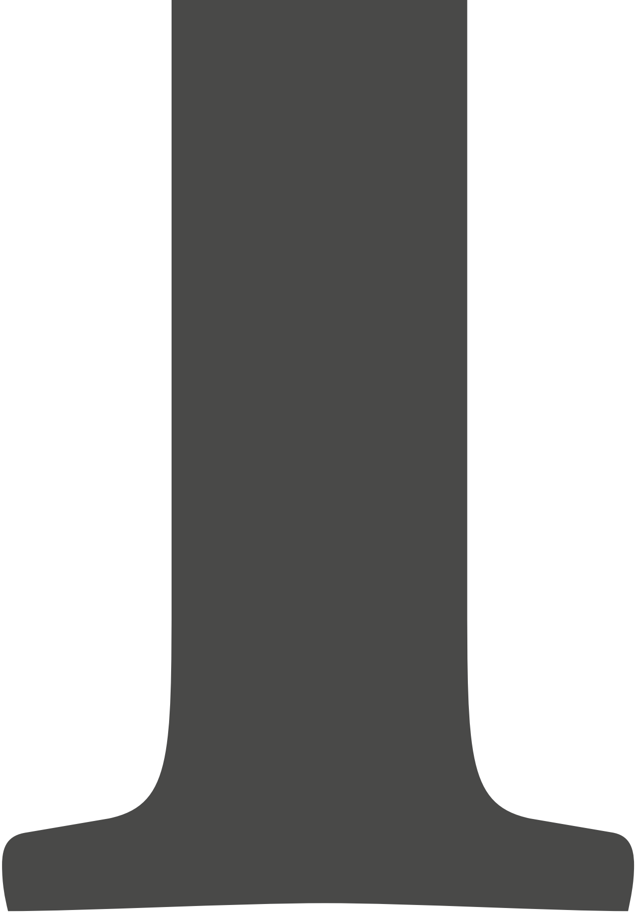


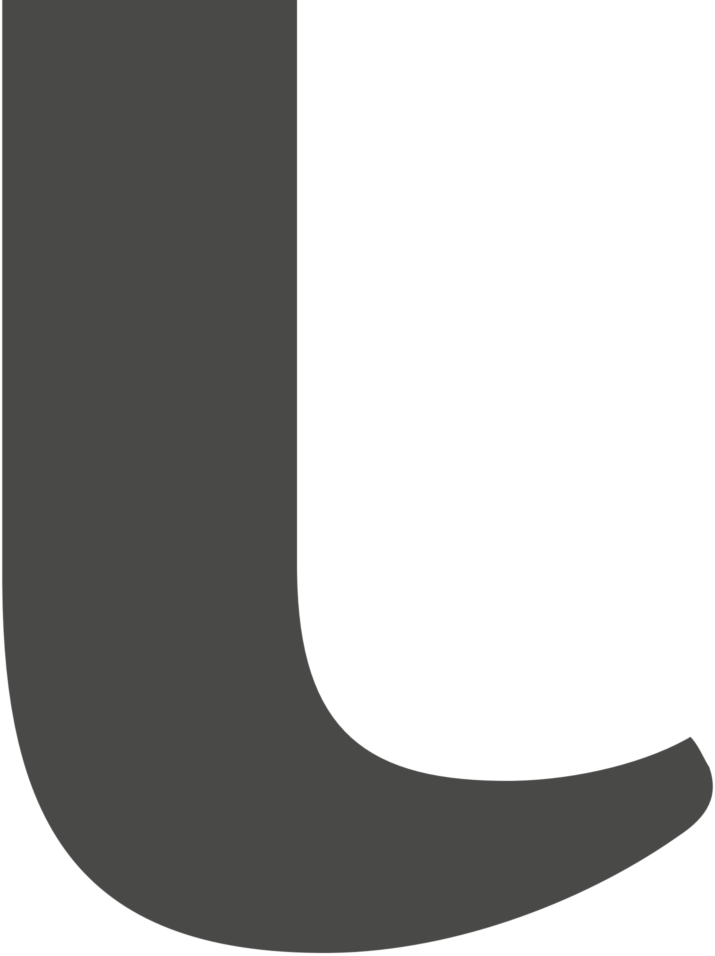
1

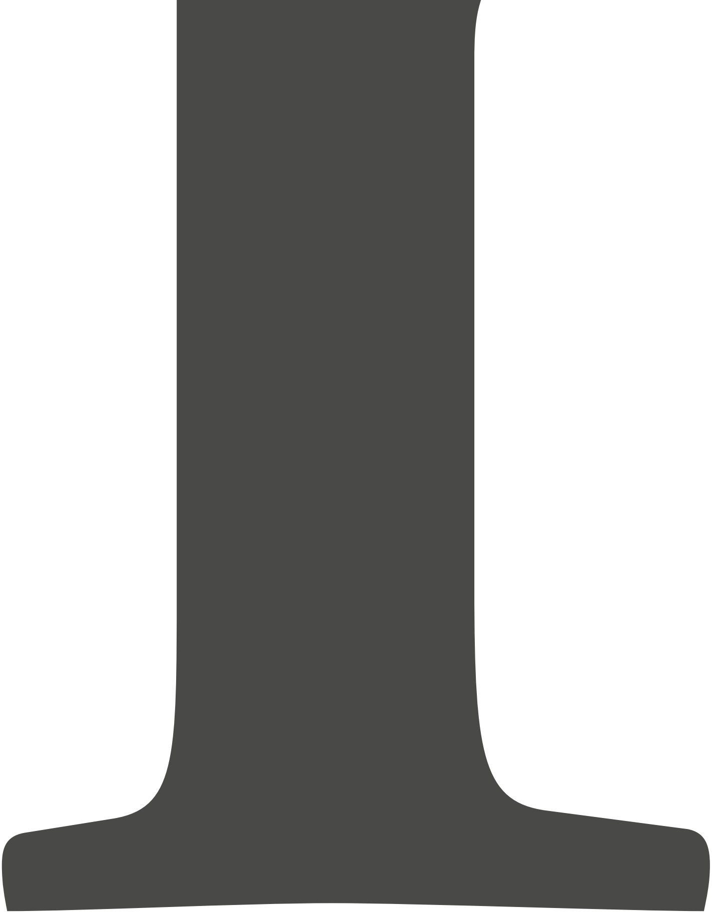


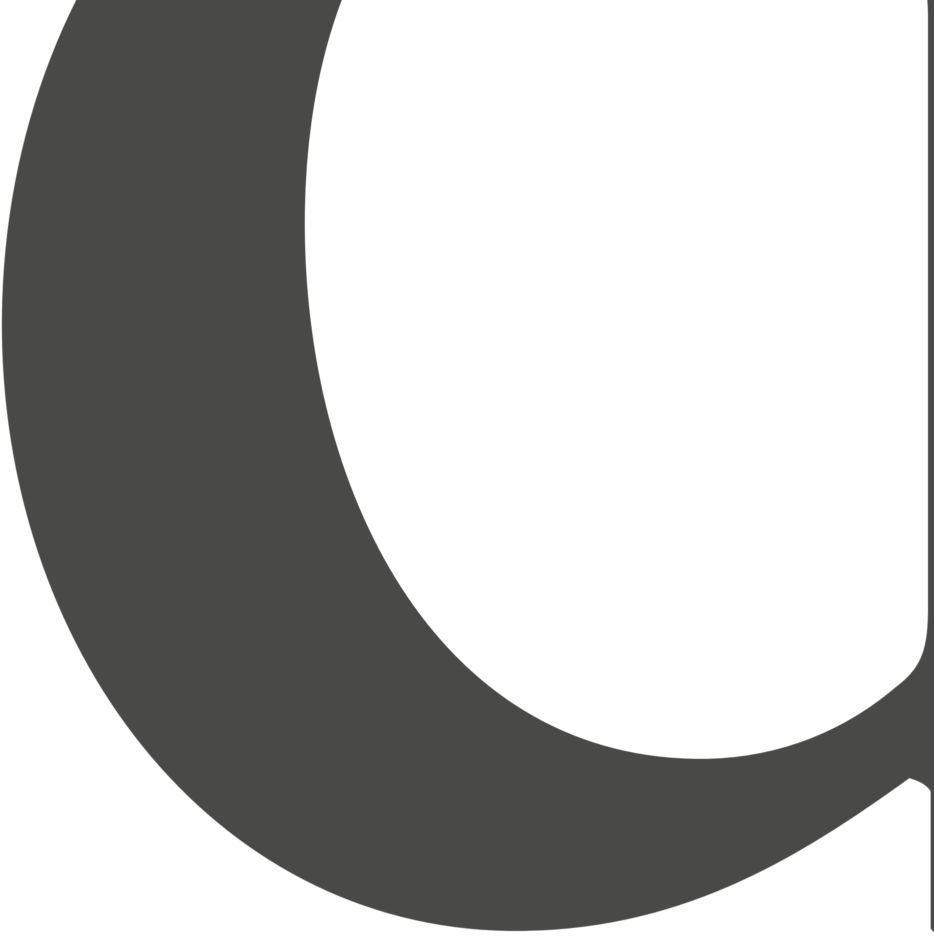


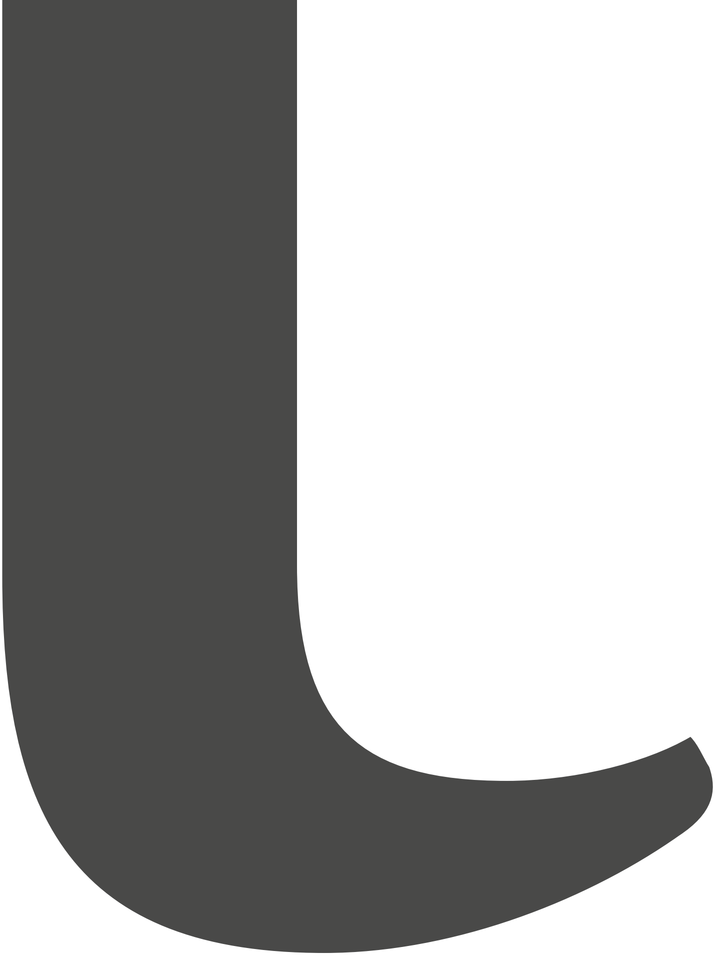


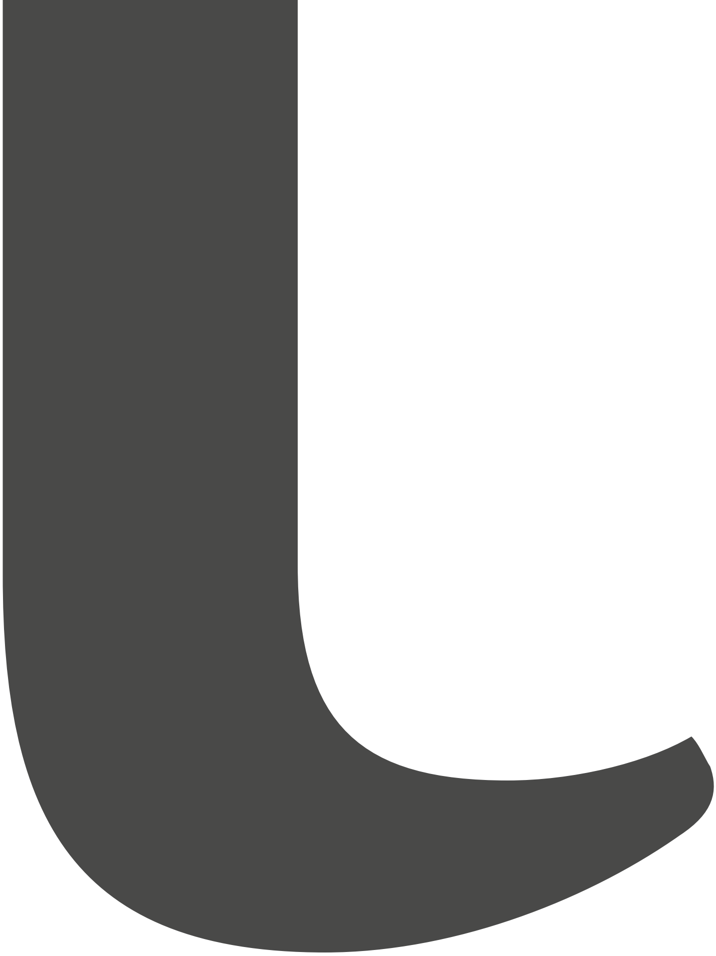


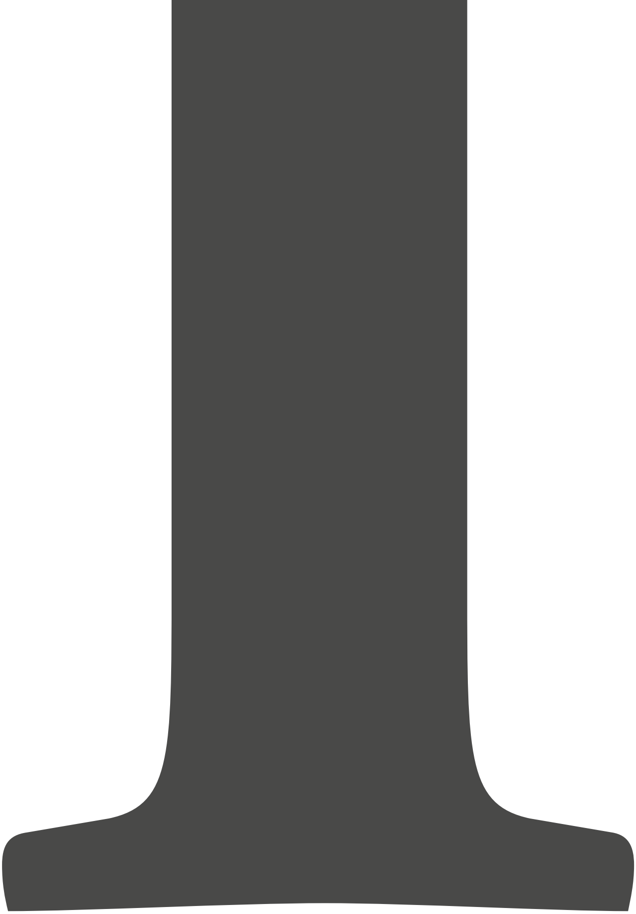


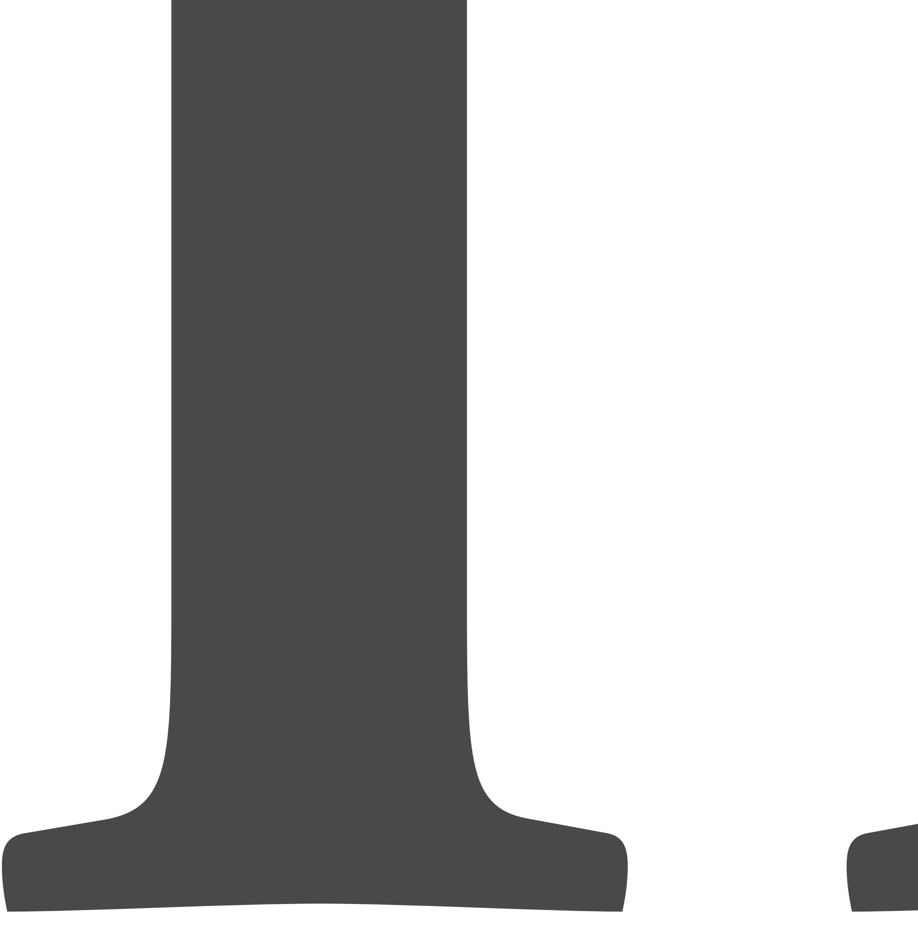


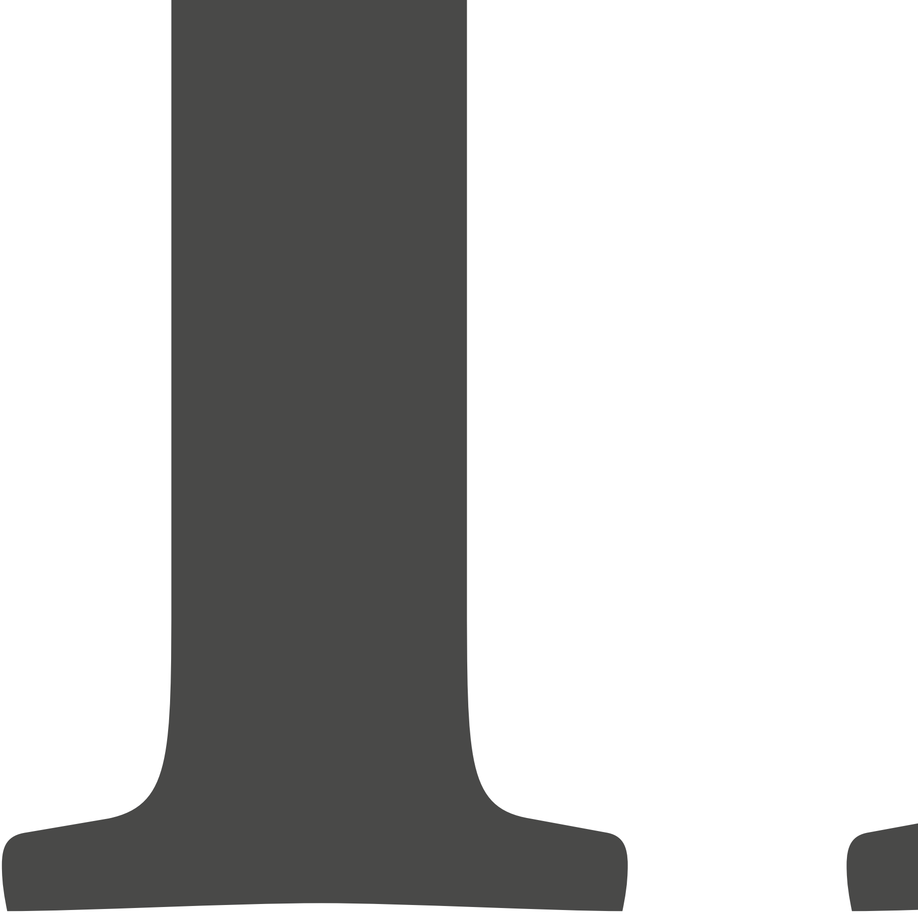


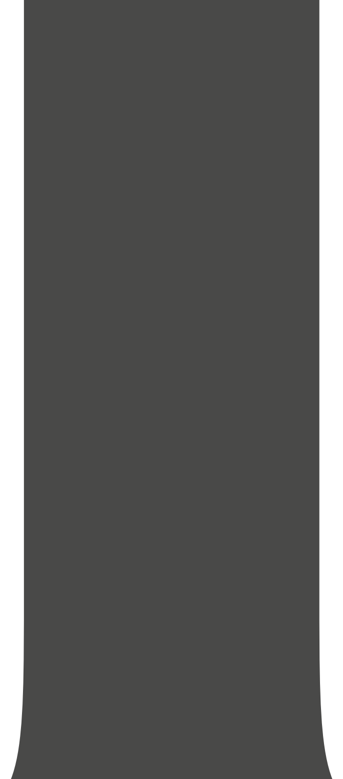


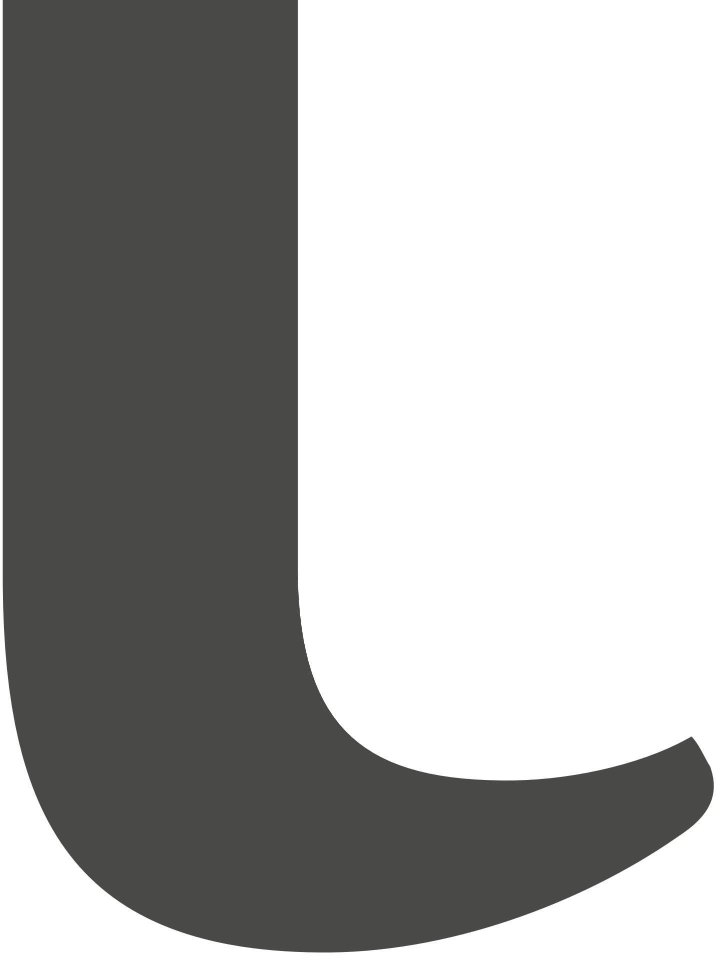


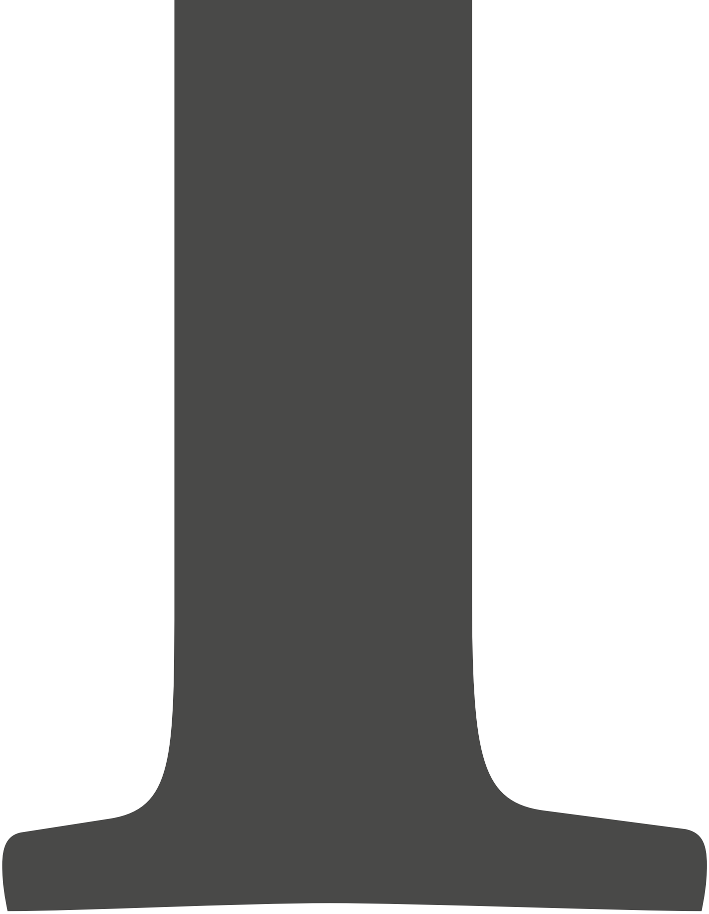


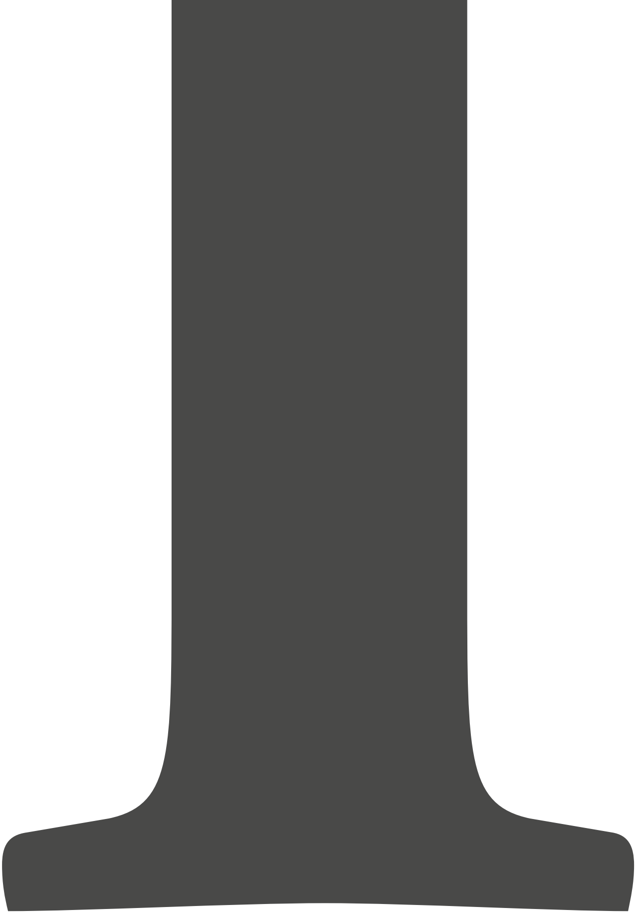




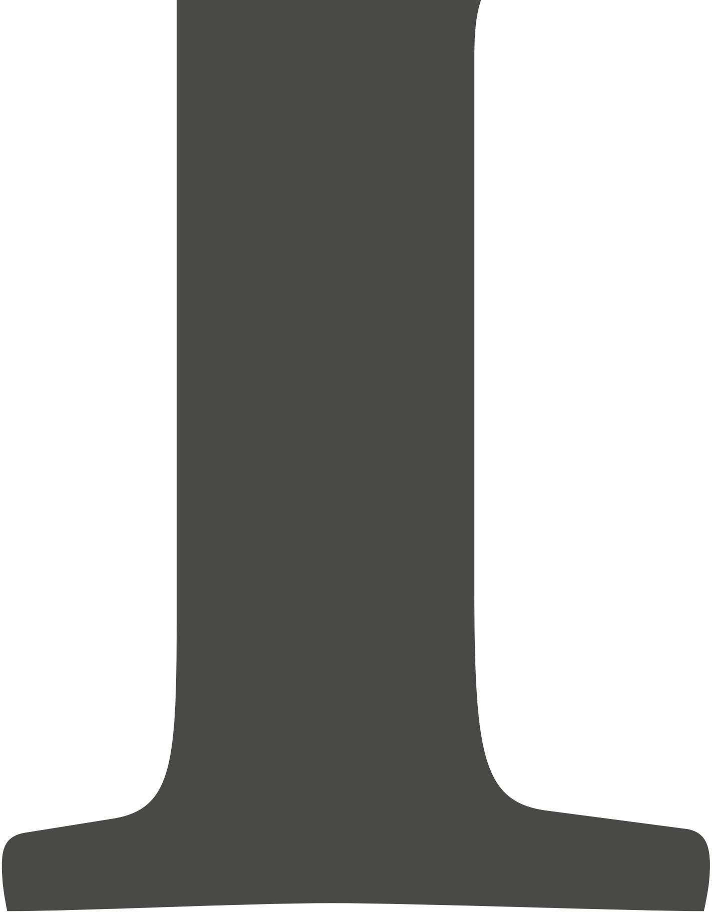


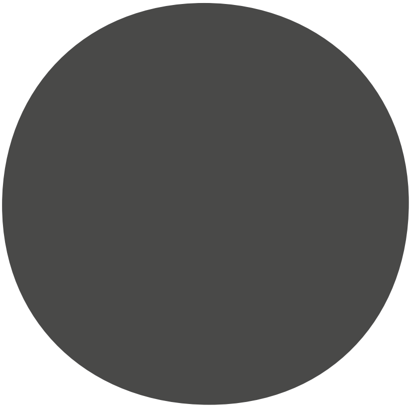




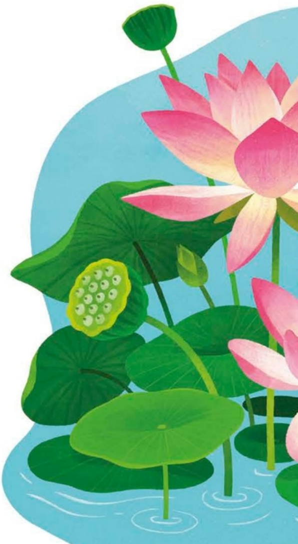


V





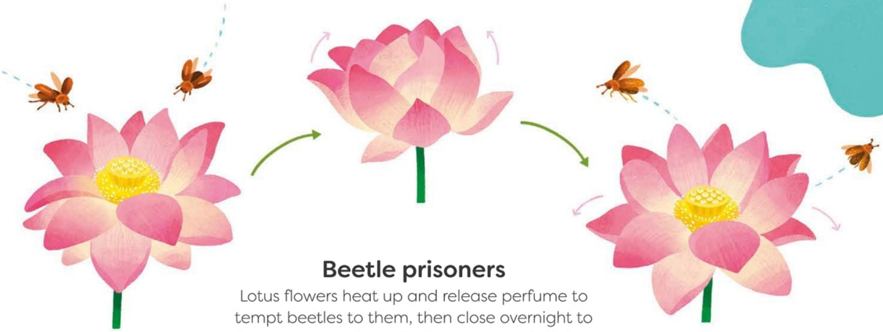
Lotus



Lotus

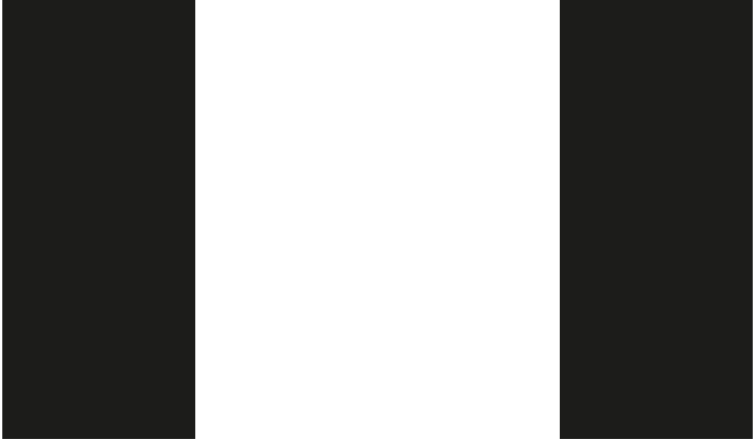
(Nelumbo nu

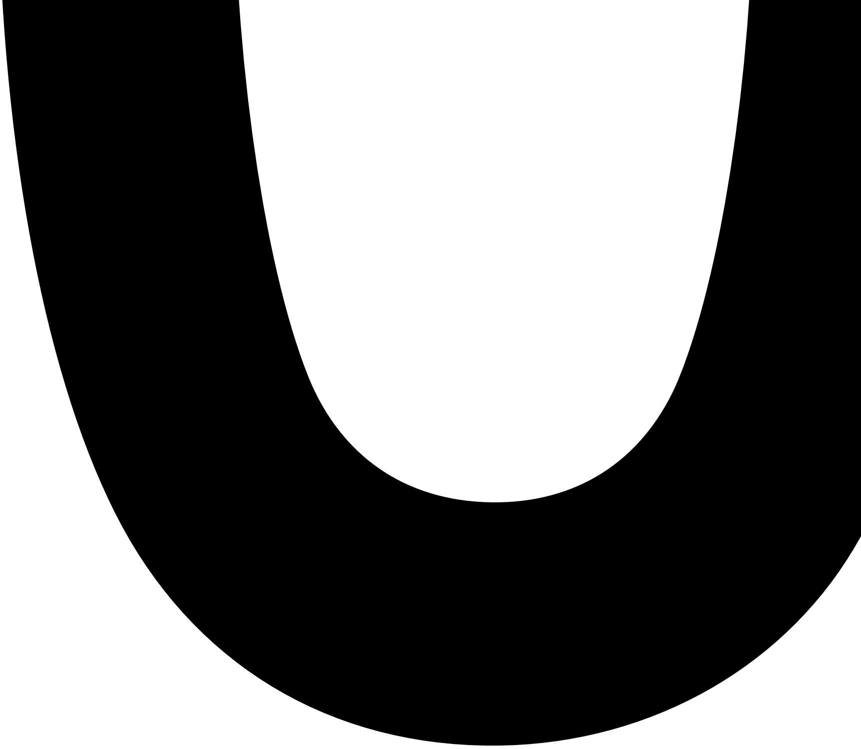
The lotus grows i
water in warm
southern and eas
from India all t
to Japa



Beetle prisoners

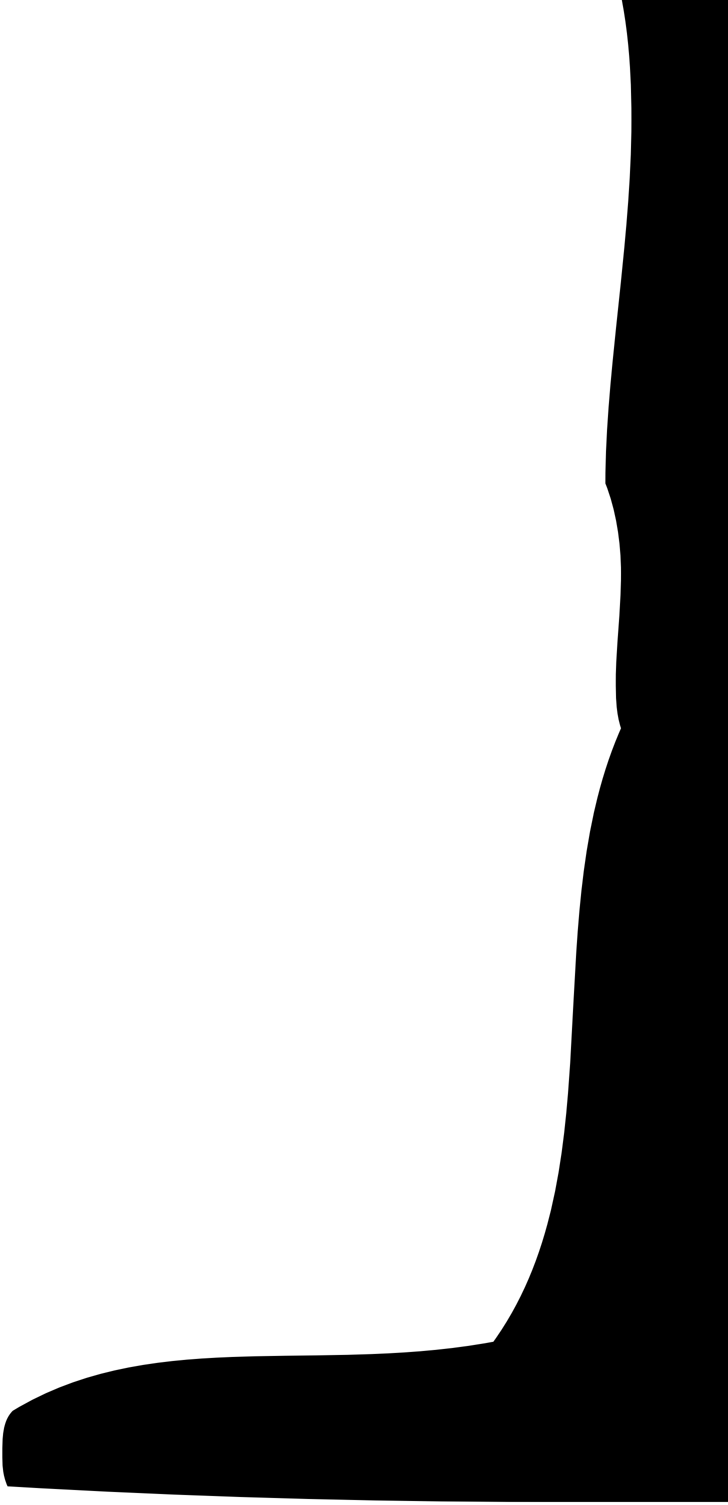
Lotus flowers heat up and release perfume to tempt beetles to them, then close overnight to trap the insects inside! Next morning, the flowers open to release the beetles, now covered in pollen. When the beetles visit another lotus flower, they pollinate it with the pollen.

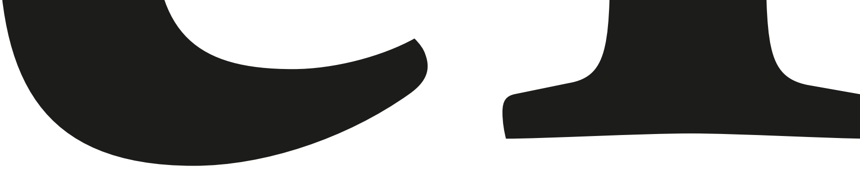




[redacted]

U

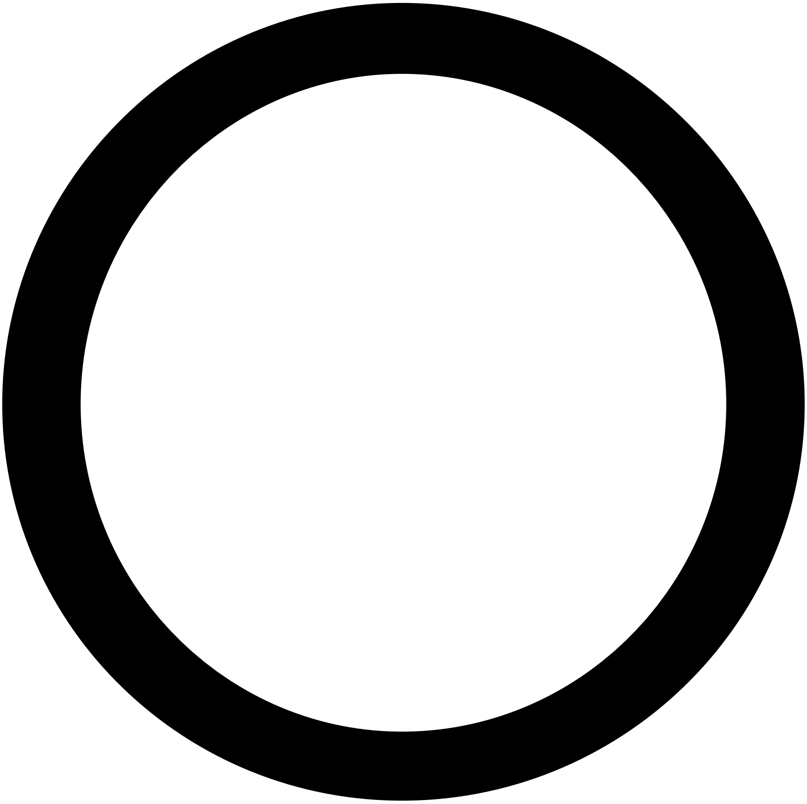




L

te

tr



p

fl

([illegible]

T

w

S

fr

t

B

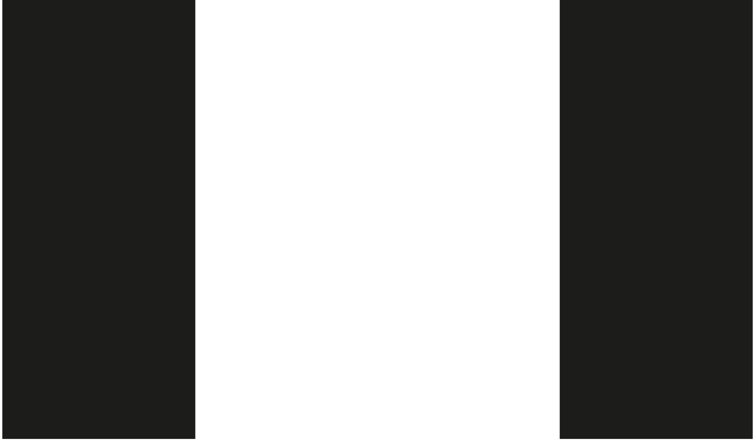
fl

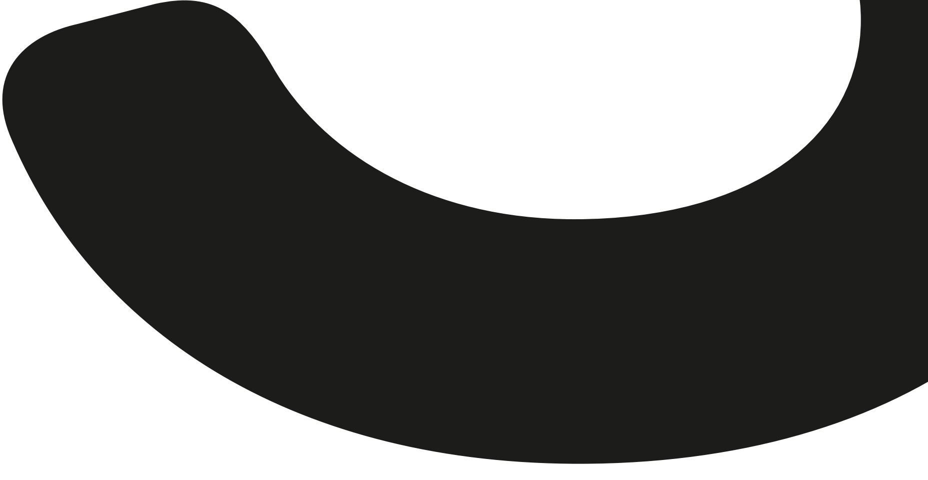
F

B

C

p





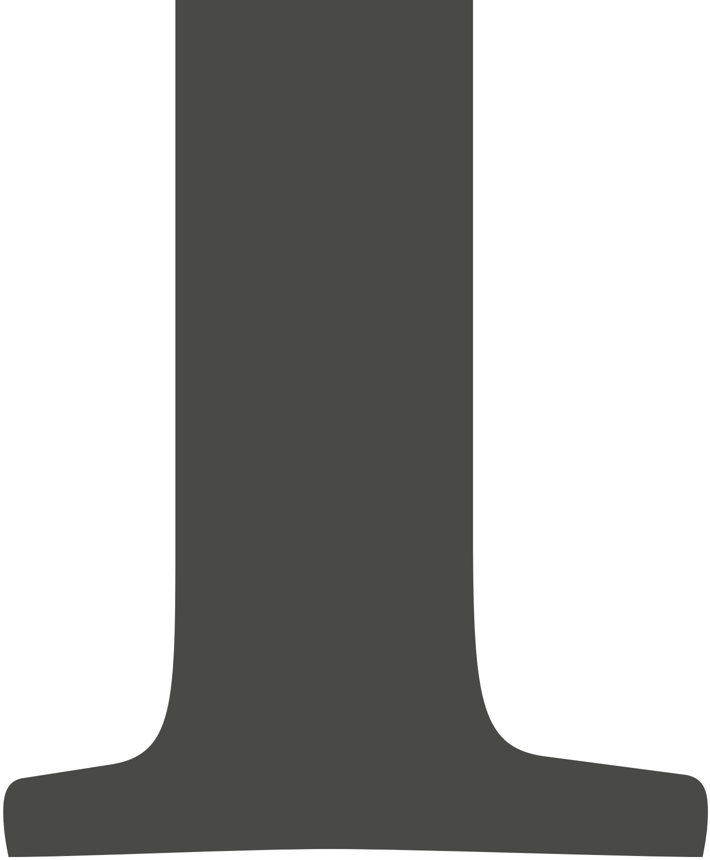
T

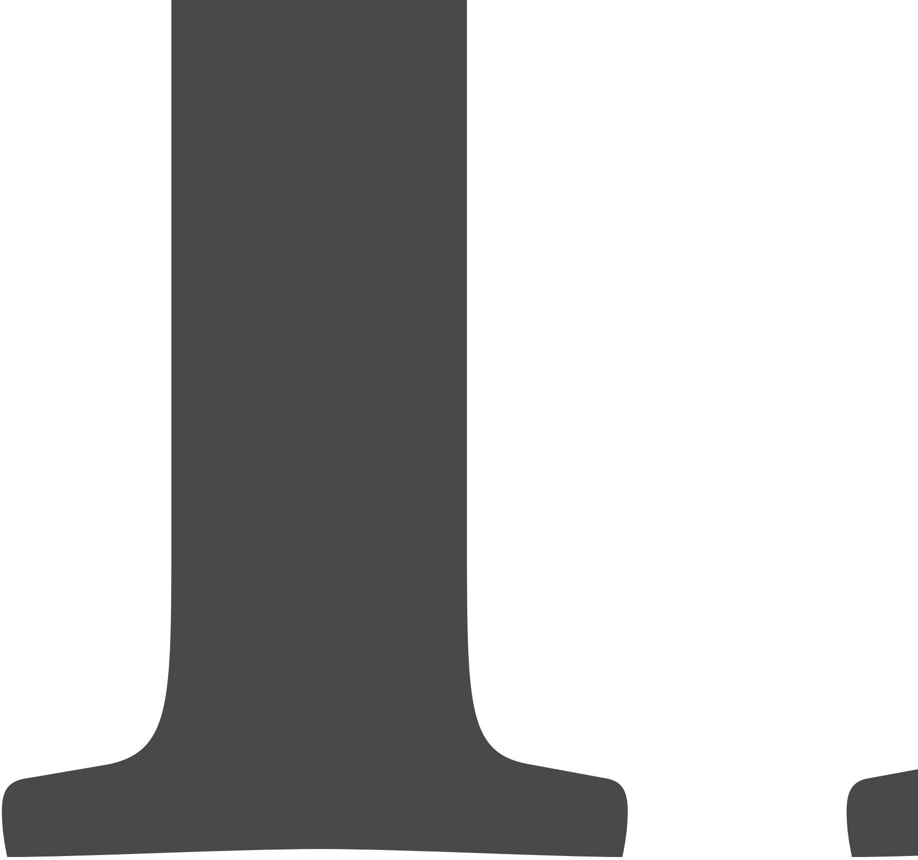
th

fu

lt

10





T

sr

g

T

fl

S

b

Y

sr

th

C

fo

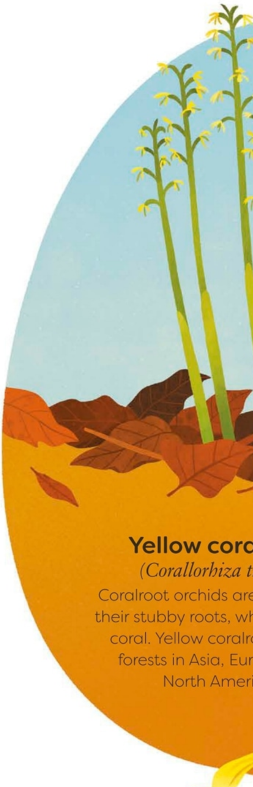
T

a

th

a

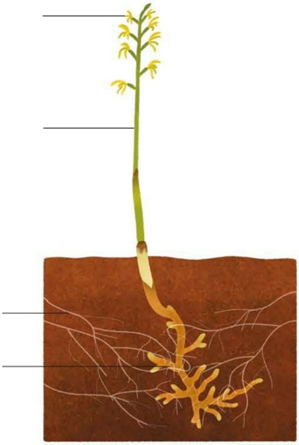
Coralroot orchid



Yellow cora

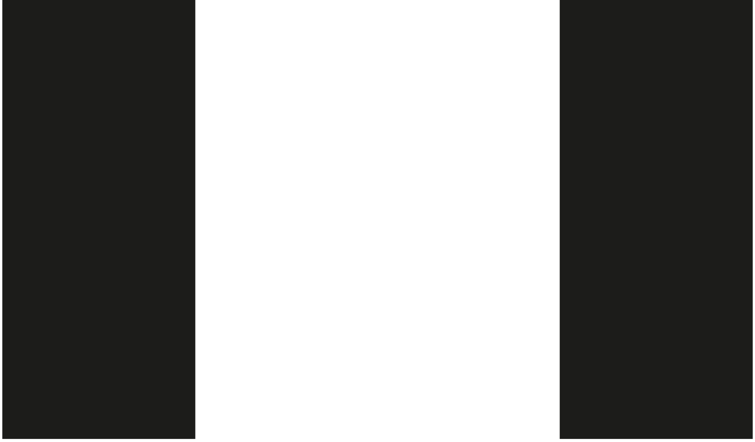
(Corallorhiza t

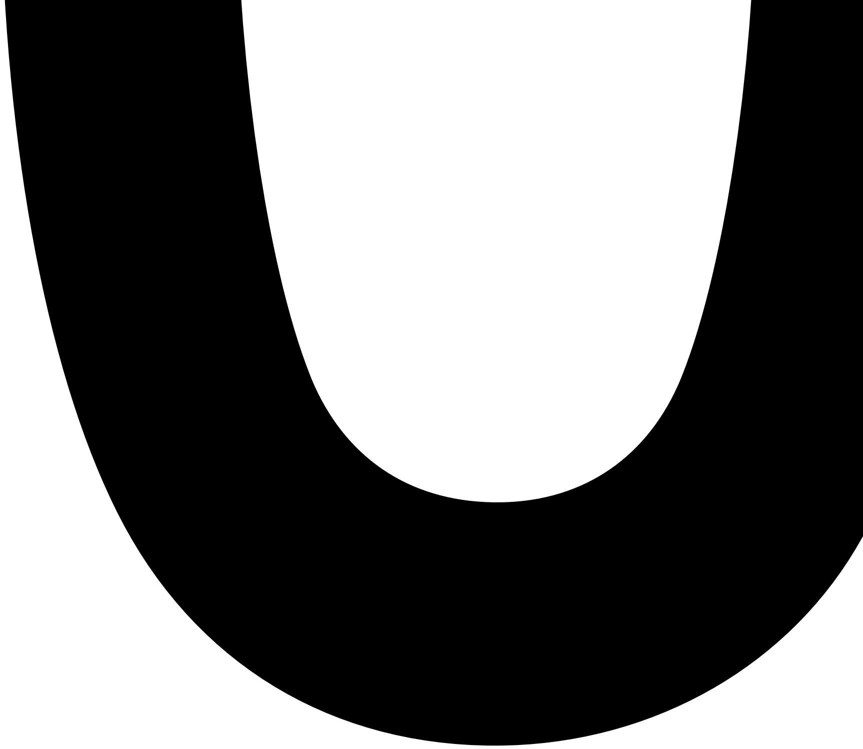
Coralroot orchids are
their stubby roots, wh
coral. Yellow coralro
forests in Asia, Eur
North Ameri

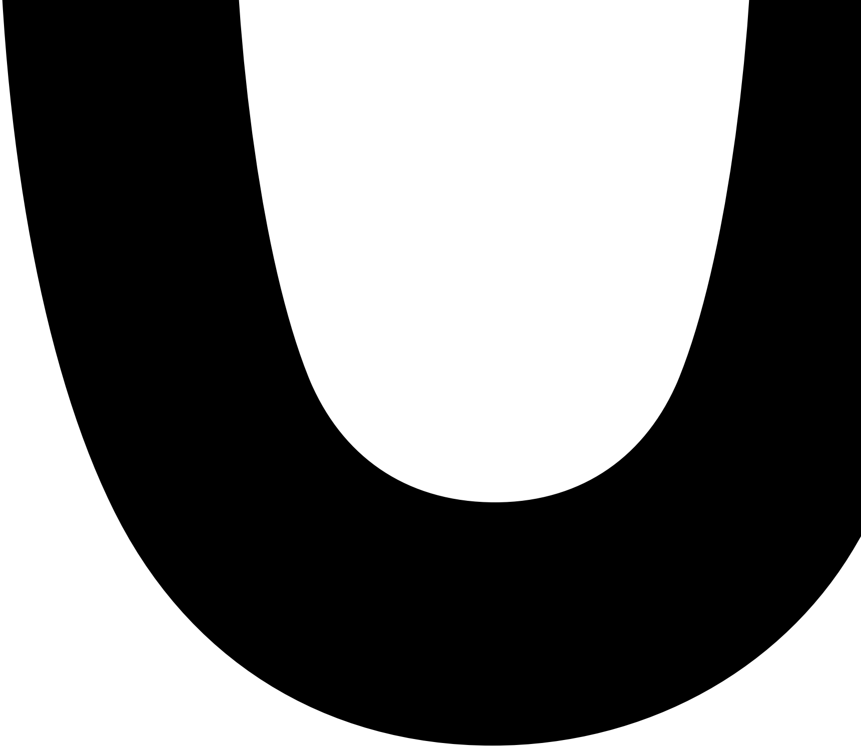


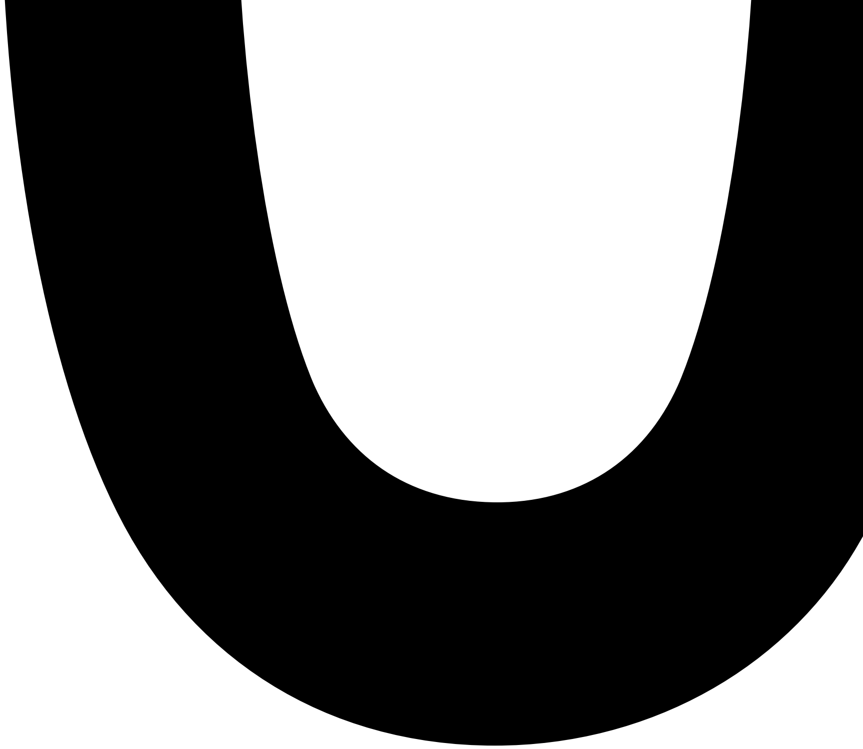
Roots that steal

Coralroot orchids have thick, lumpy roots that provide a snug home for soil fungi. The orchids take some water, nutrients, and sugars from the fungi they live with, but never enough to harm or kill them.

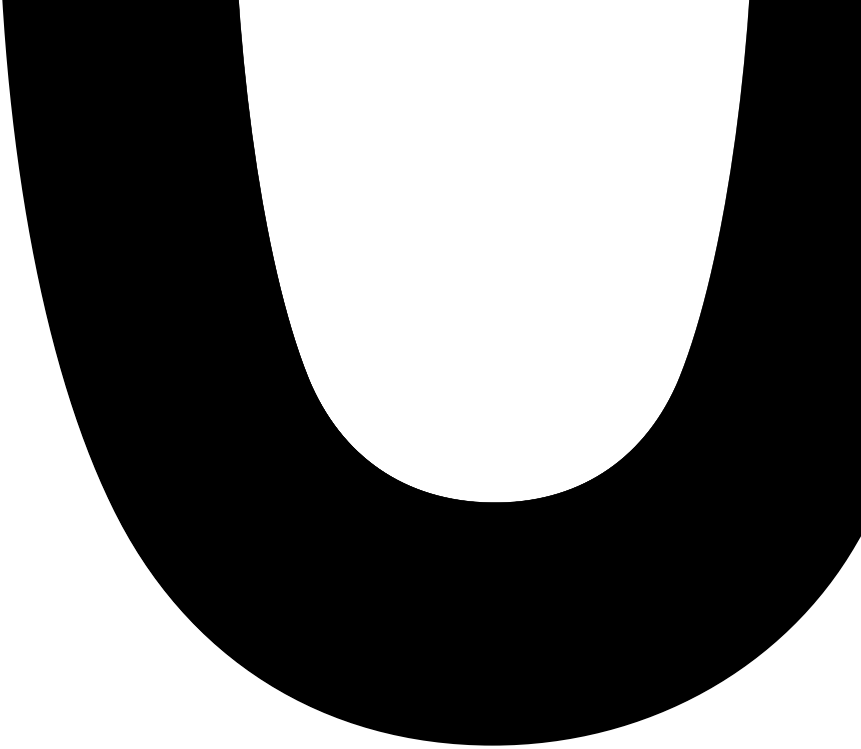








[redacted]



[redacted]

C

lu

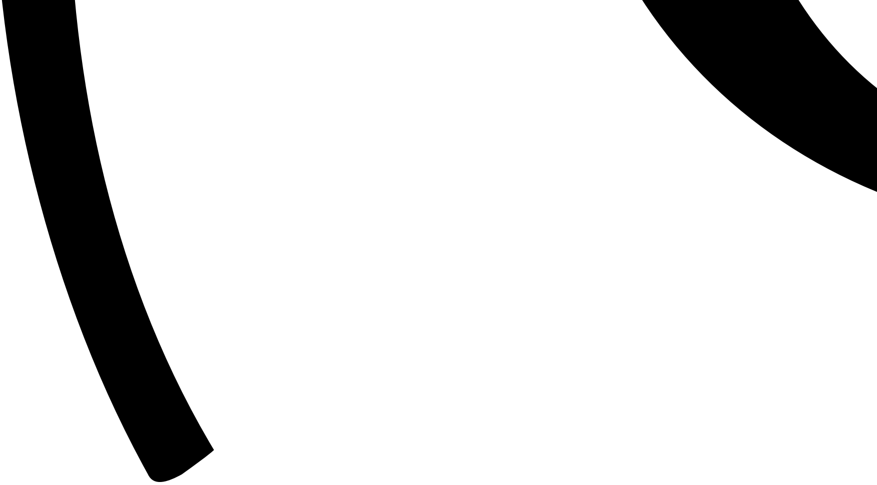
h

t

SU

w

h



C

th

C

f

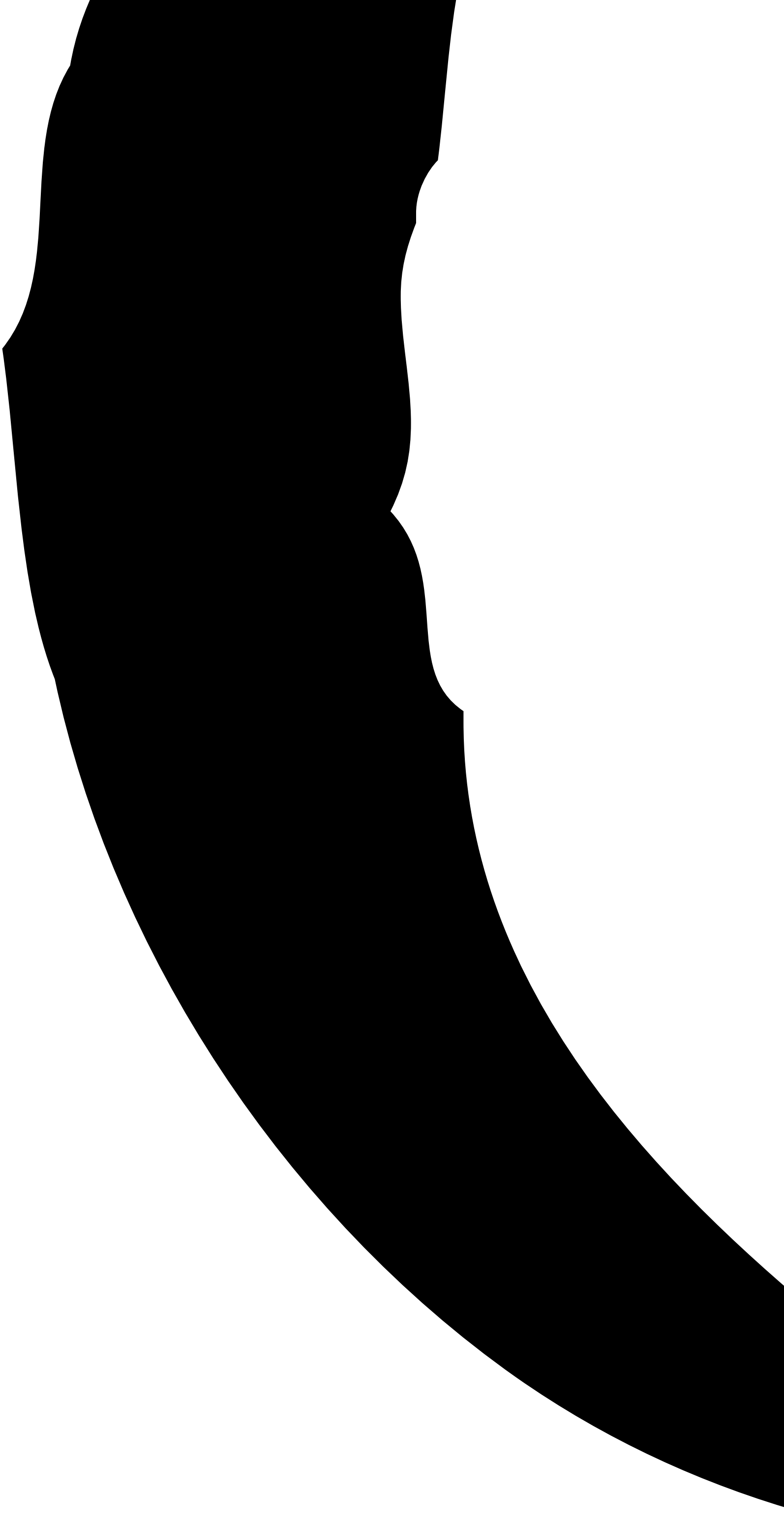
N

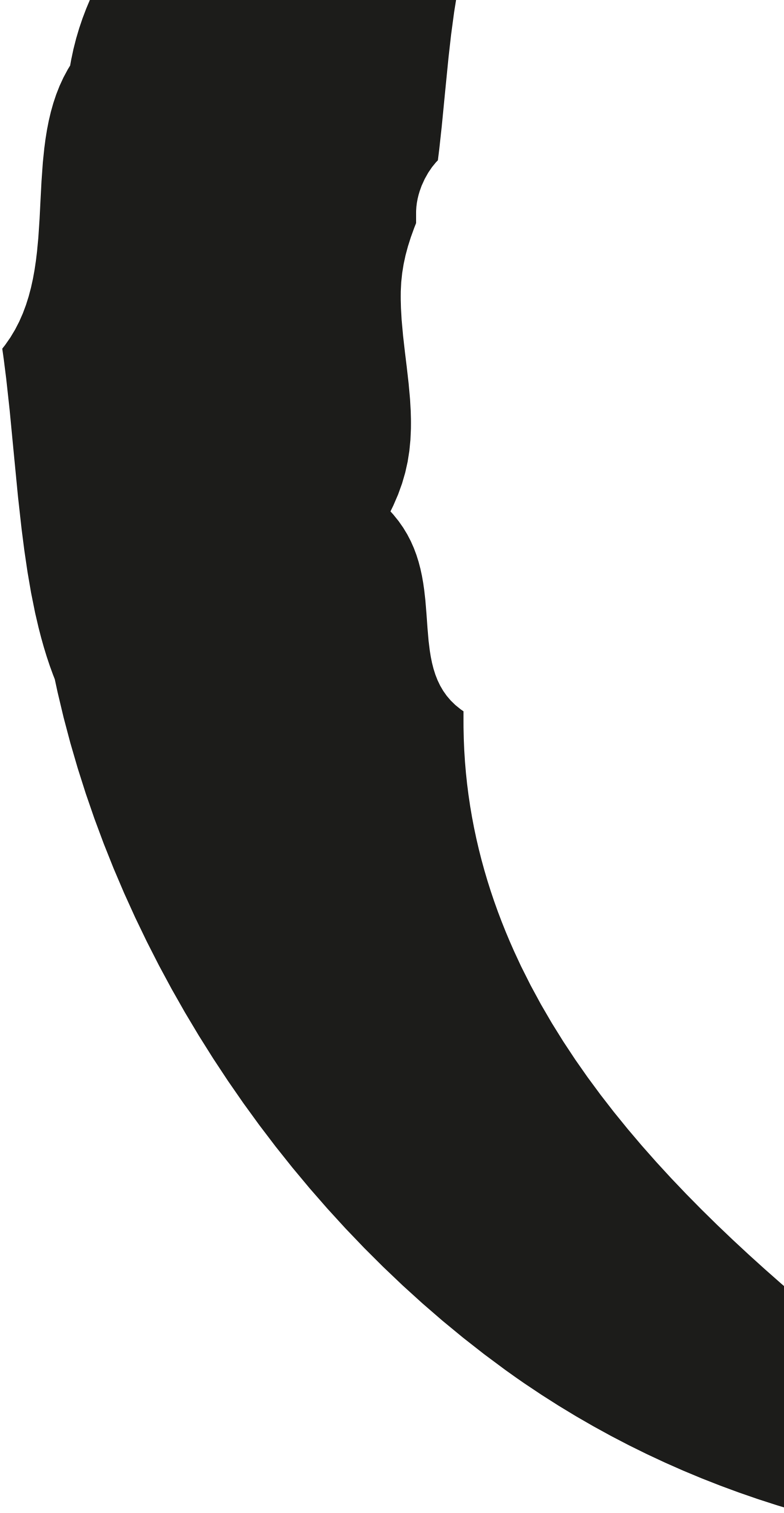
F

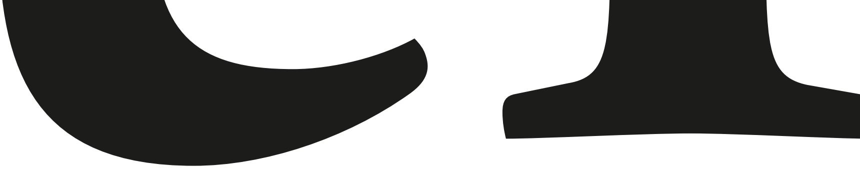
F

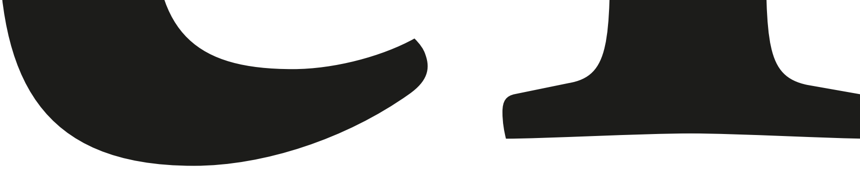
st

R



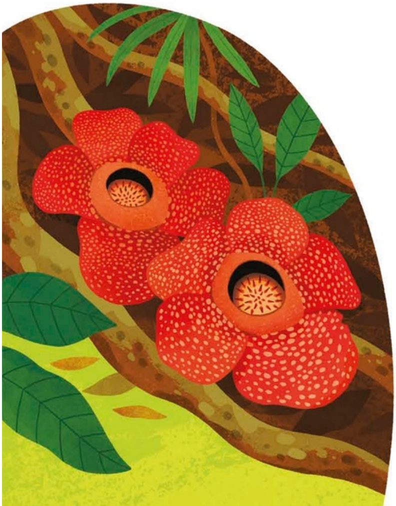




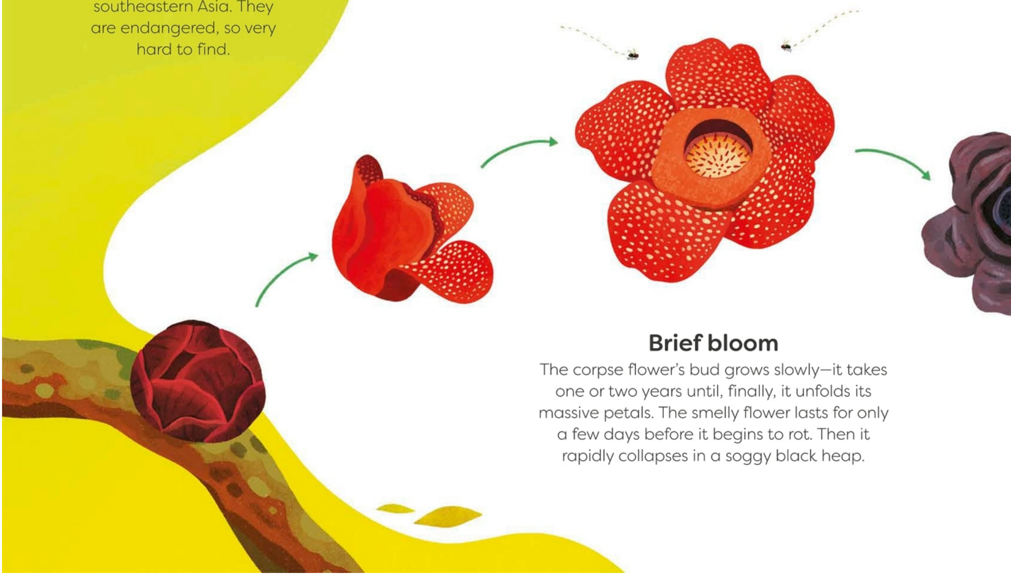


F

Corpse flower

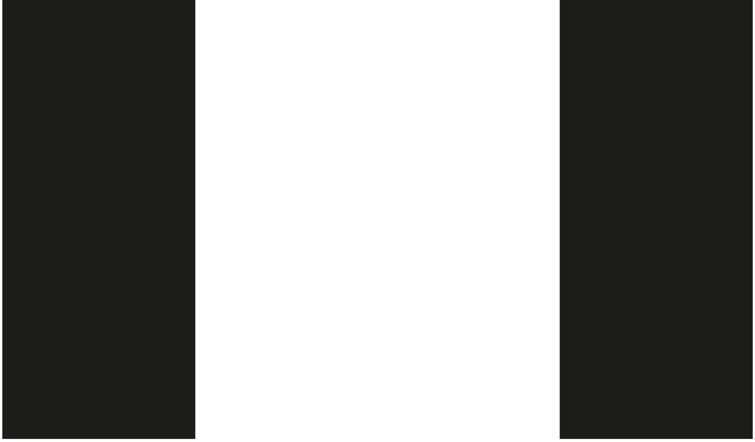


Corpse flower
(Rafflesia arnoldii)
Corpse flowers live only in the rain forests of southeastern Asia. They are endangered, so very hard to find.



Brief bloom

The corpse flower's bud grows slowly—it takes one or two years until, finally, it unfolds its massive petals. The smelly flower lasts for only a few days before it begins to rot. Then it rapidly collapses in a soggy black heap.



T

o

m

a

r

([illegible]

C

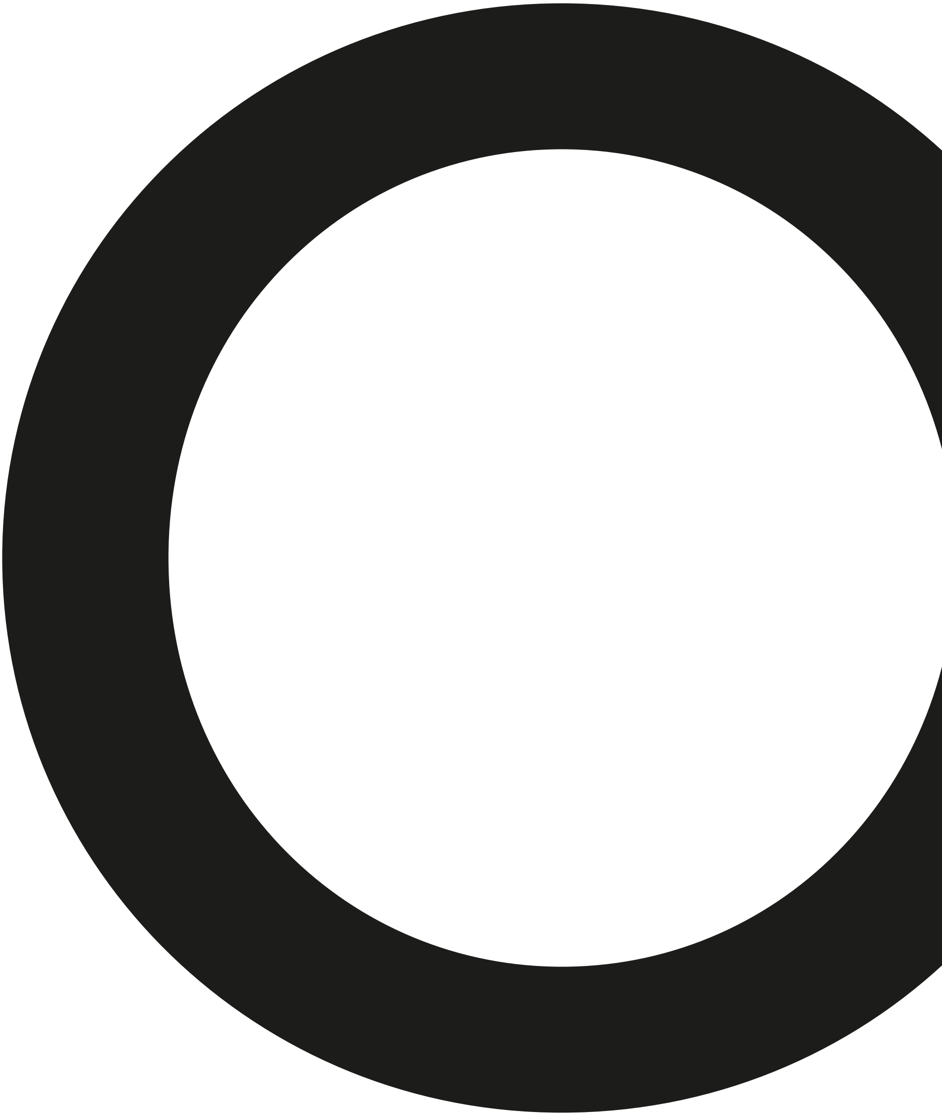
in

S

a

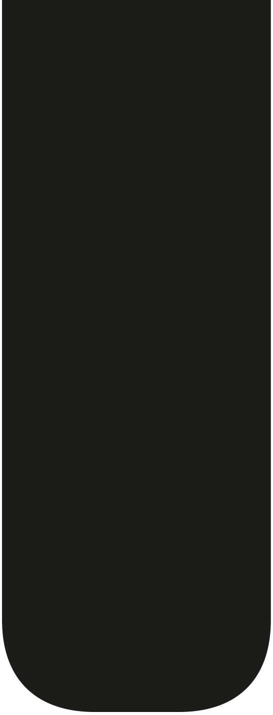
h

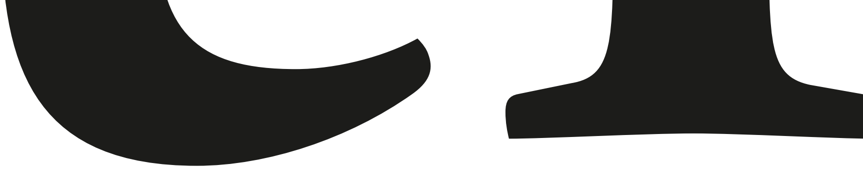
B



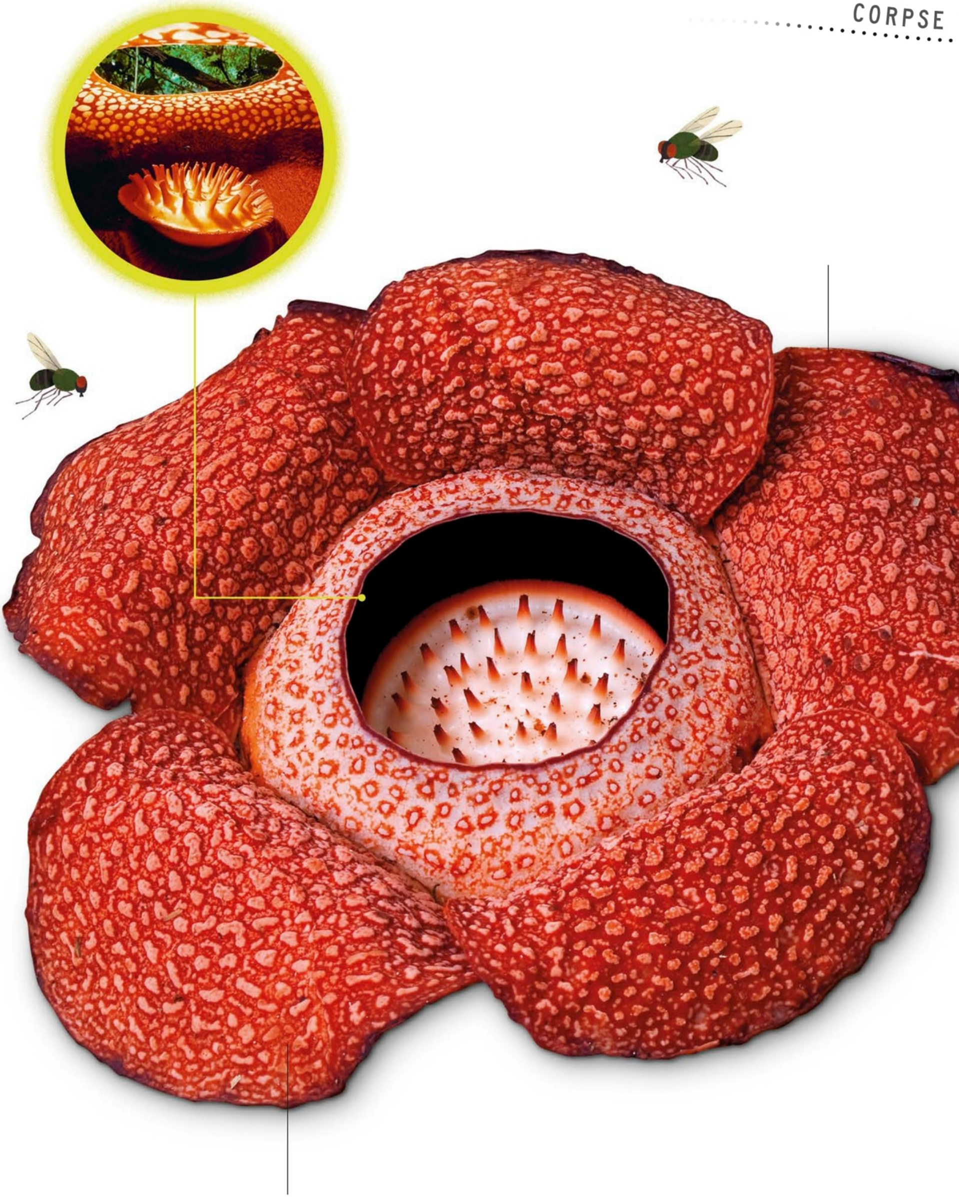
B

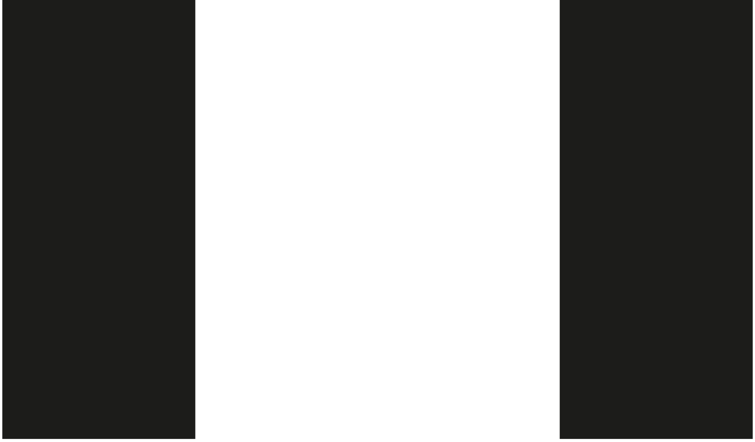
R

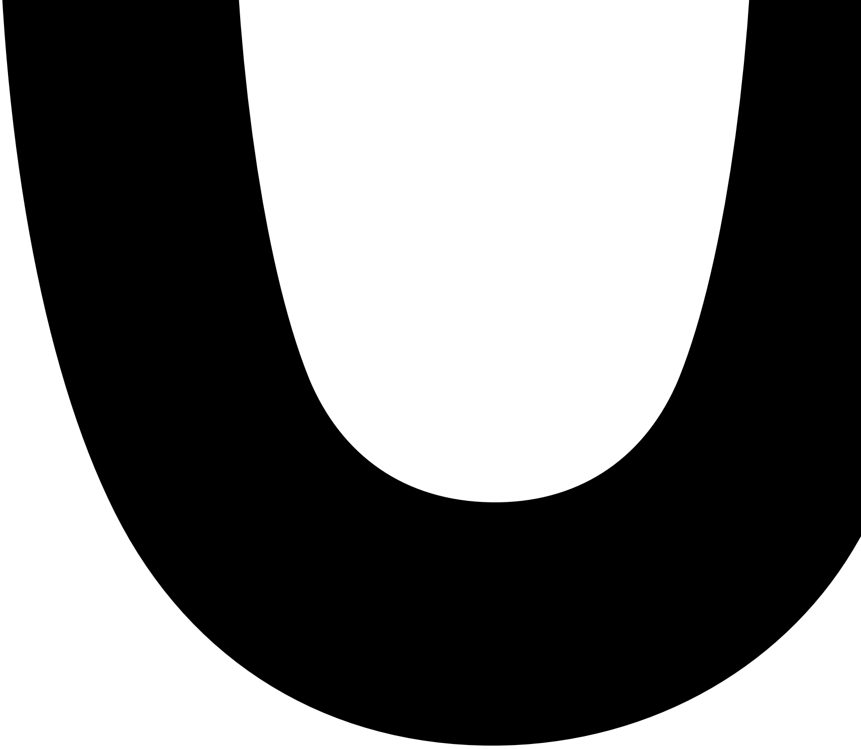




CORPSE

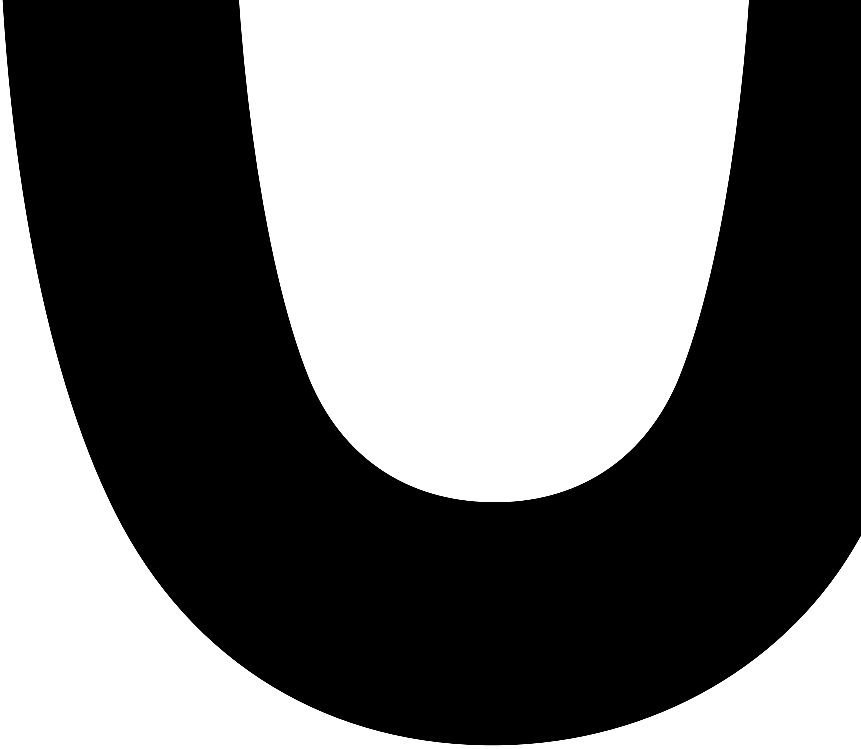






[redacted]

[redacted]



"

l

fl

th

d

iS

C

m

C

th

C

Fi

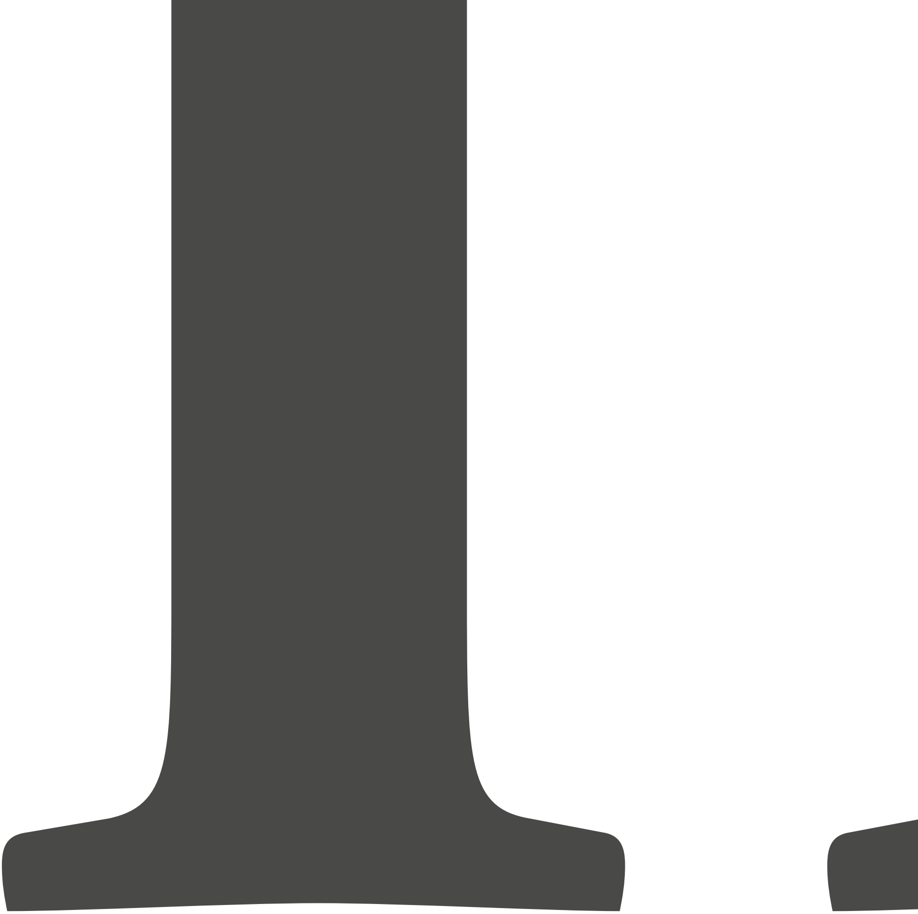
SU

CE

T

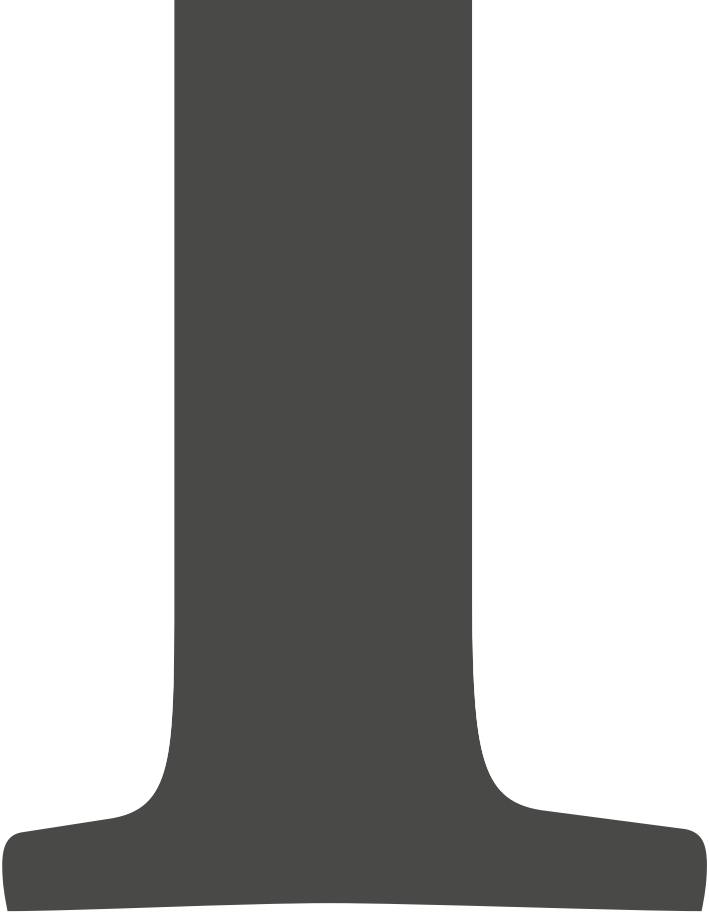
a

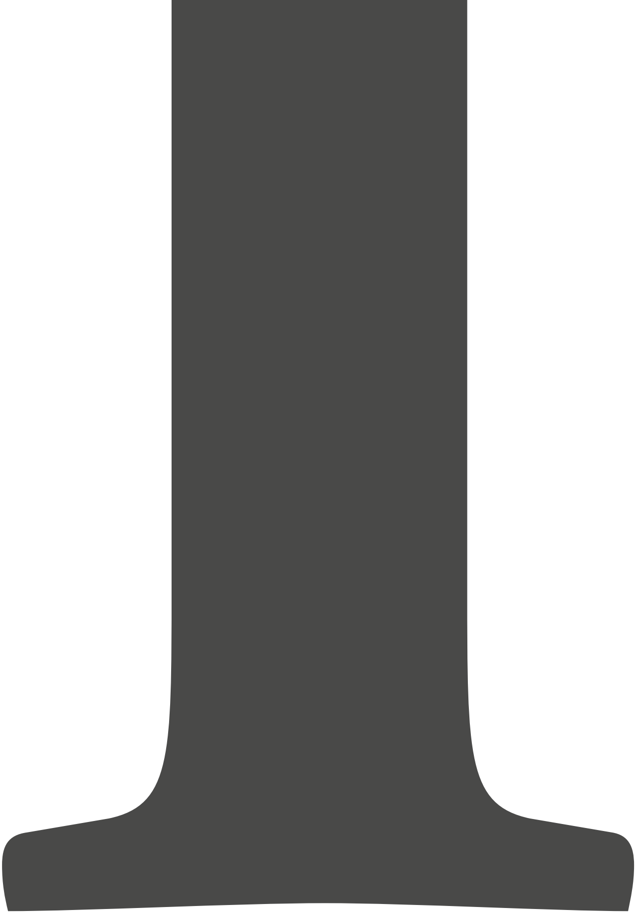
C



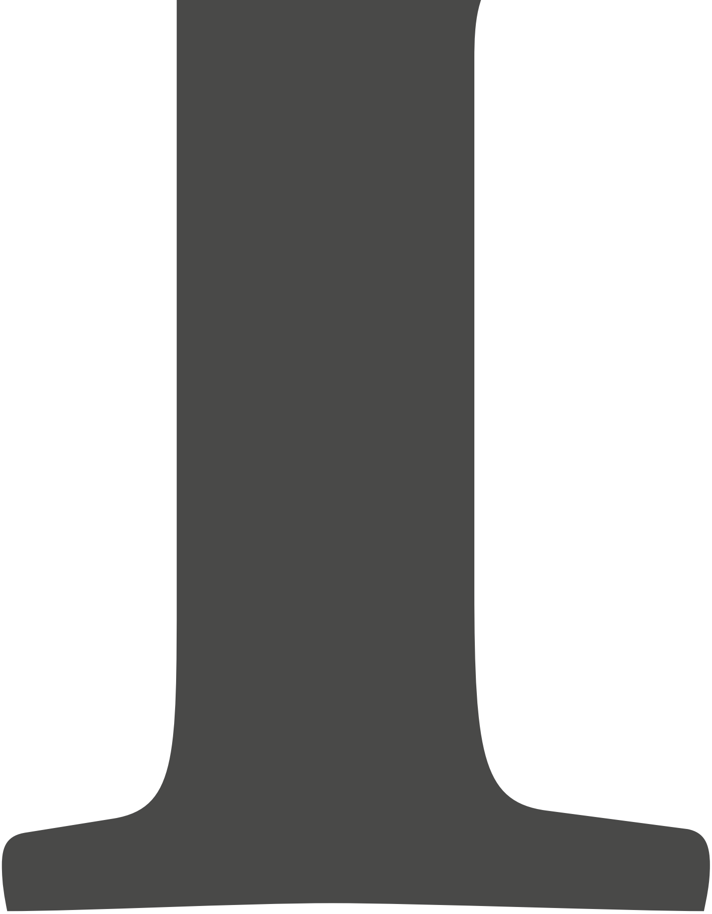
1

p

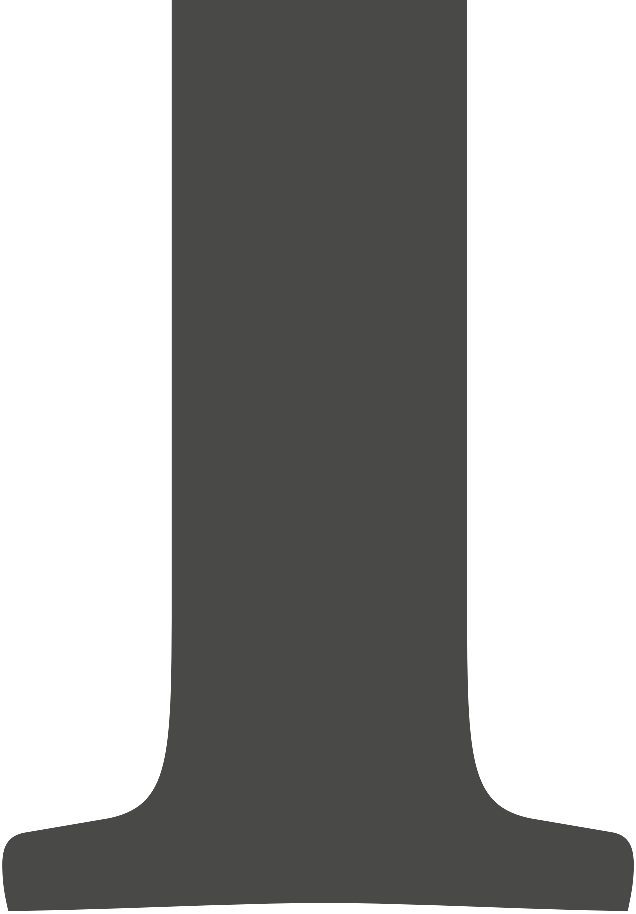


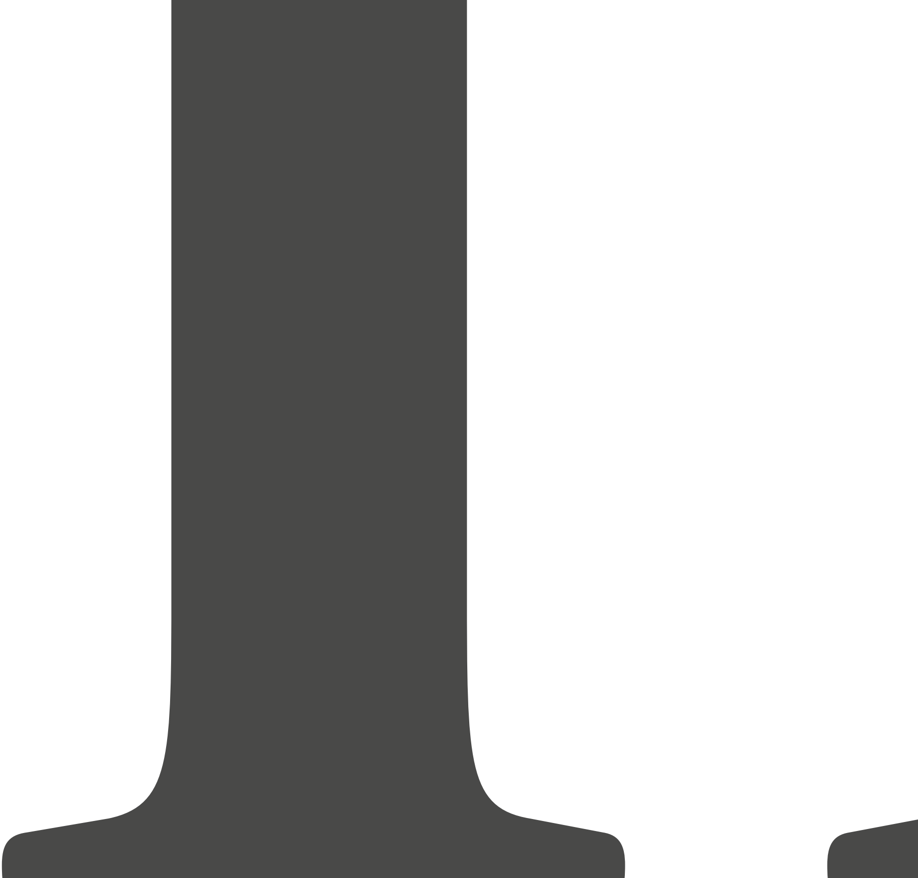


V



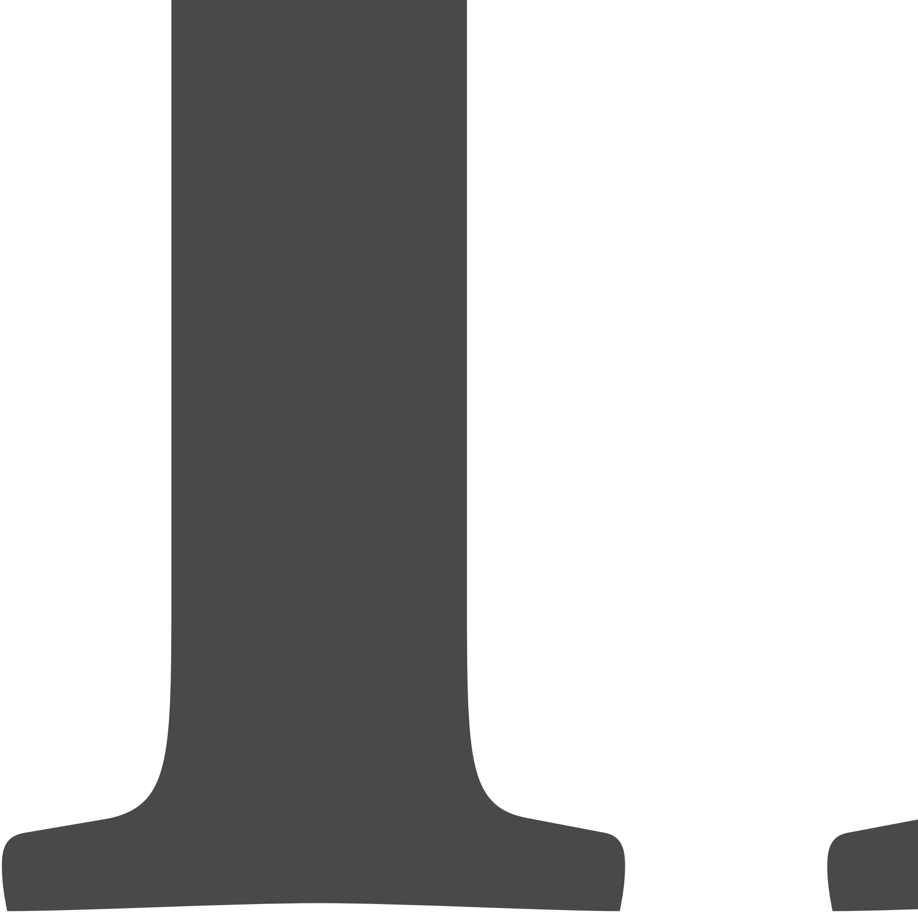
V



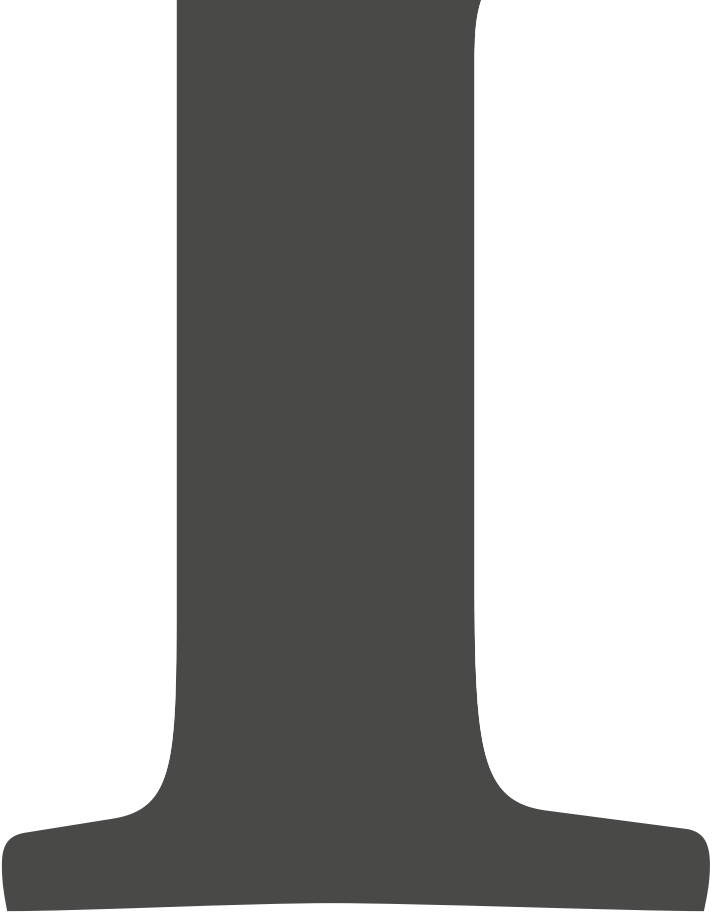


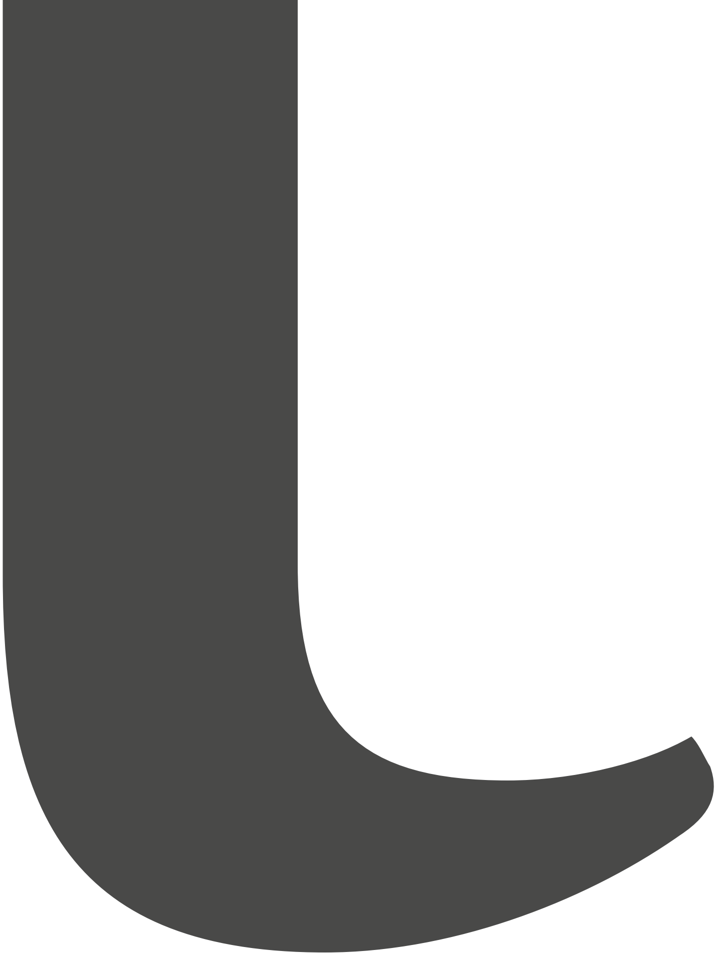
S

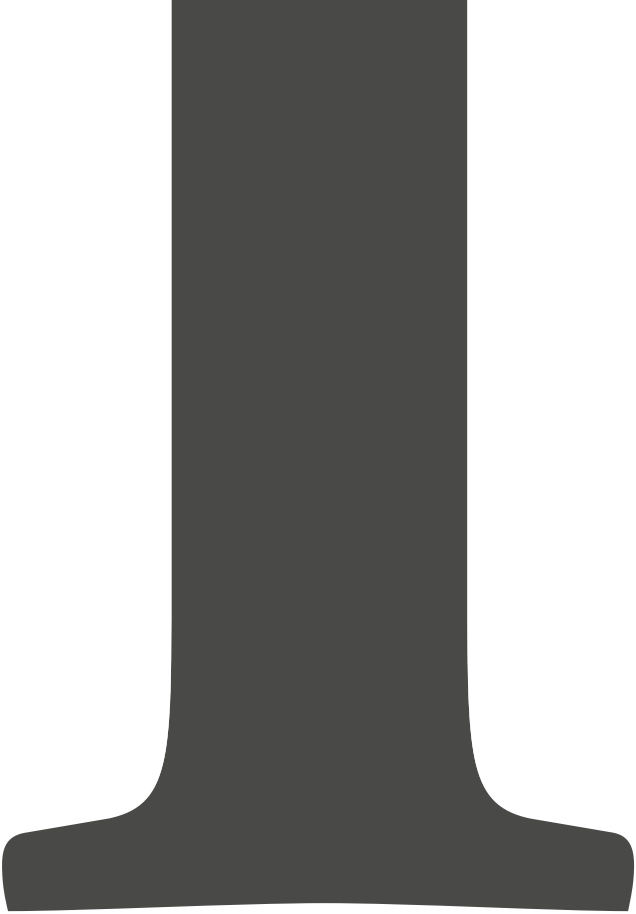
S



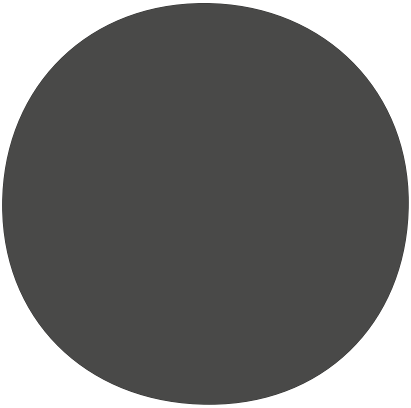
S

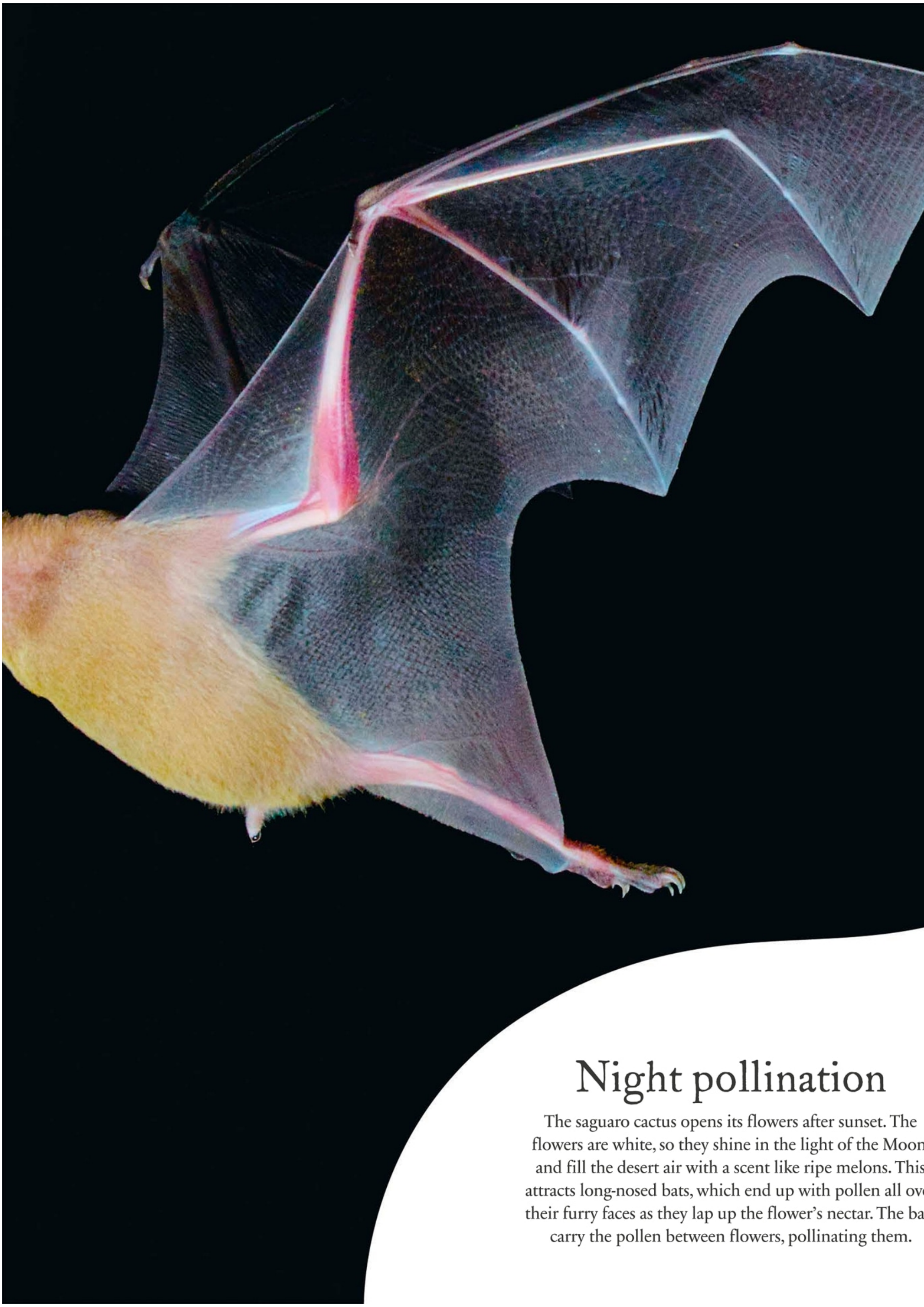






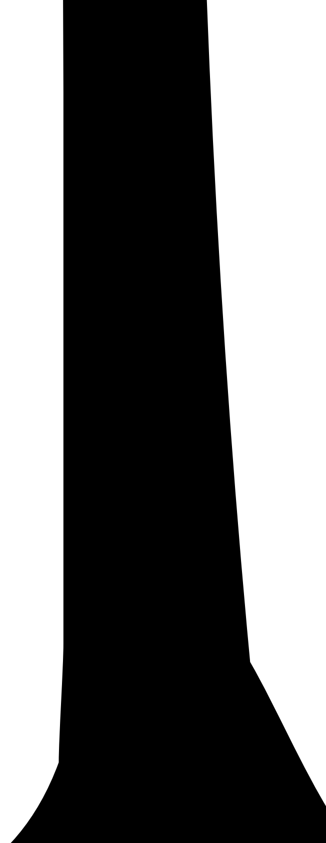
1

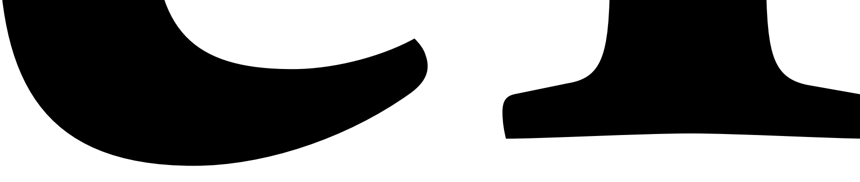


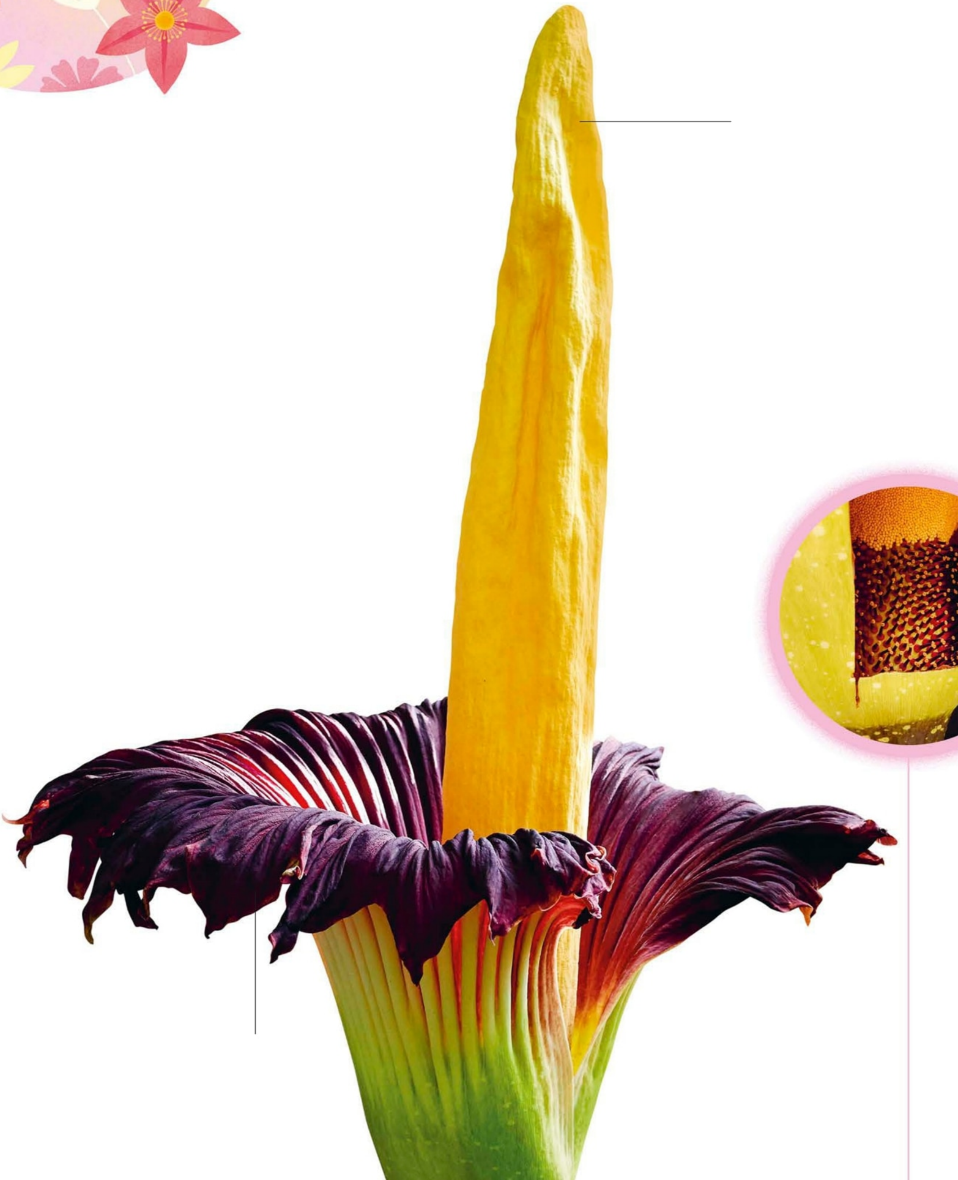


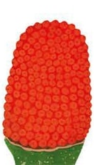
Night pollination

The saguaro cactus opens its flowers after sunset. The flowers are white, so they shine in the light of the Moon and fill the desert air with a scent like ripe melons. This attracts long-nosed bats, which end up with pollen all ov their furry faces as they lap up the flower's nectar. The ba carry the pollen between flowers, pollinating them.









12

T

a

C

ri

a

p

W

a

te

T

a

T

C

m

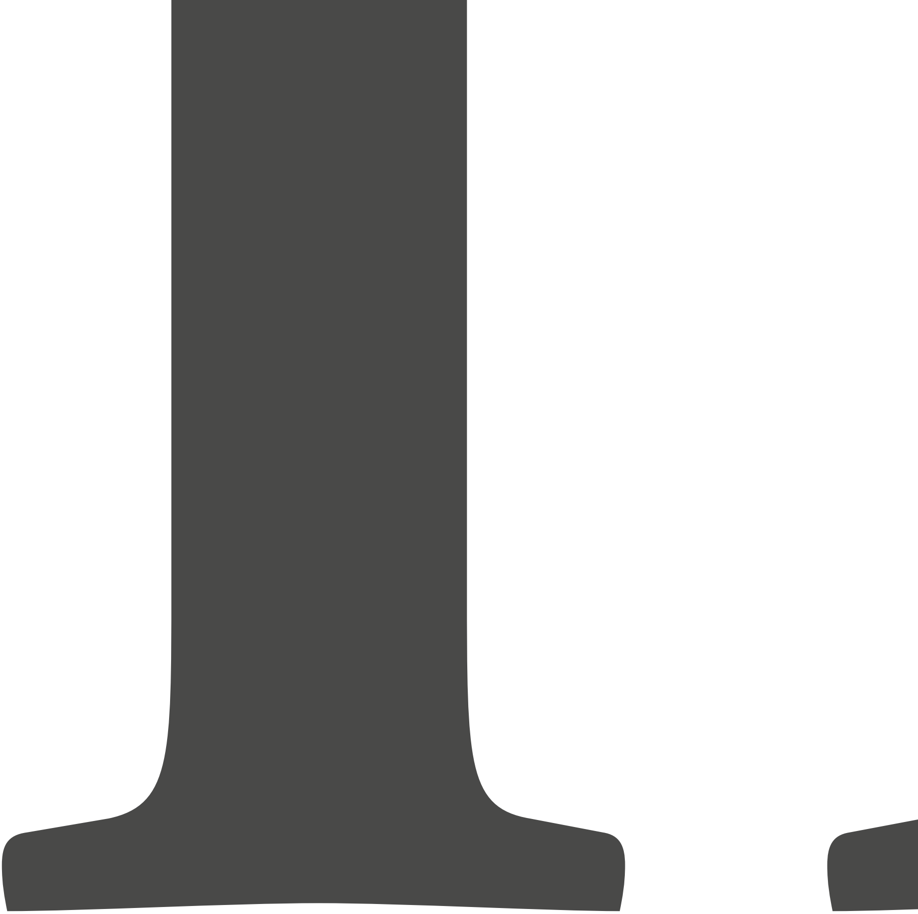
up

A

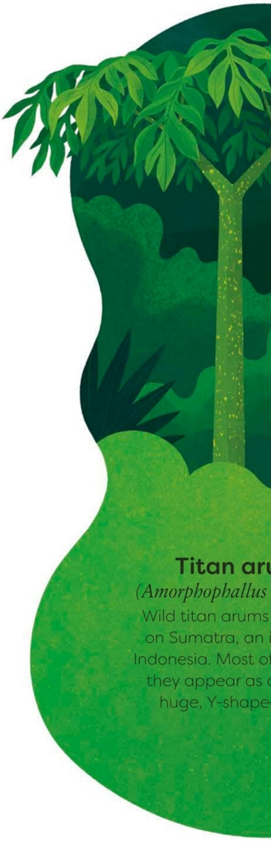
W

sp

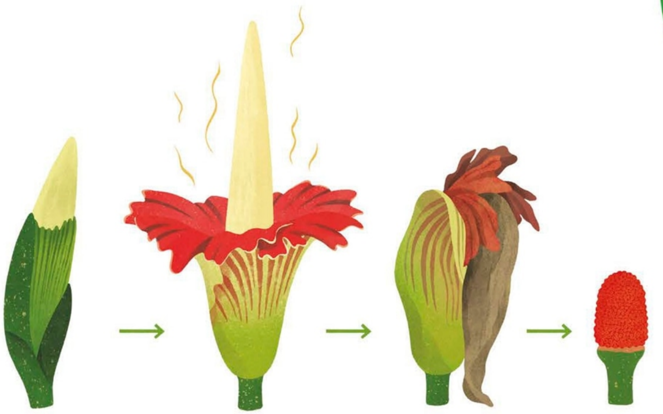
th



Titan arum



Titan aru
(Amorphophallus
Wild titan arums
on Sumatra, an
Indonesia. Most o
they appear as
huge, Y-shape



Rapid growth

A titan arum stores energy
underground stem for year
it produces a bud. The bud
fast for several weeks, then
afternoon, the flower spike
It becomes warmer and sm
overnight, but wilts the nex
The fertilized flowers devel
a mass of little red fruits.

12

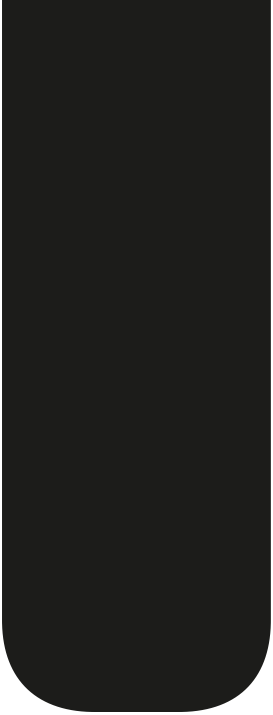
[redacted]

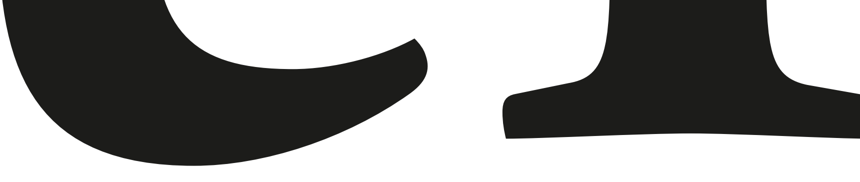
[redacted]

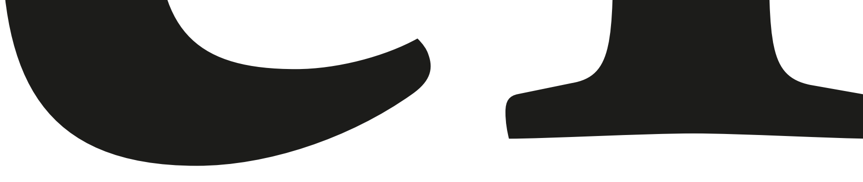
[redacted]

U

IV







A

u

it

f

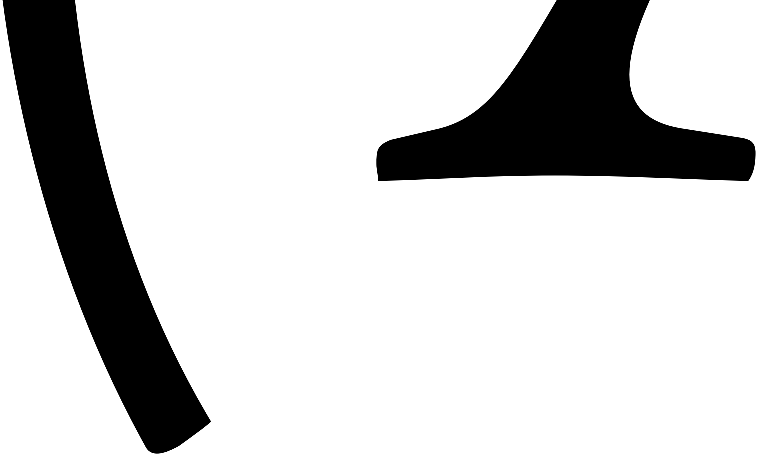
a

lt

O

T

a



W

o

ln

th

h

B

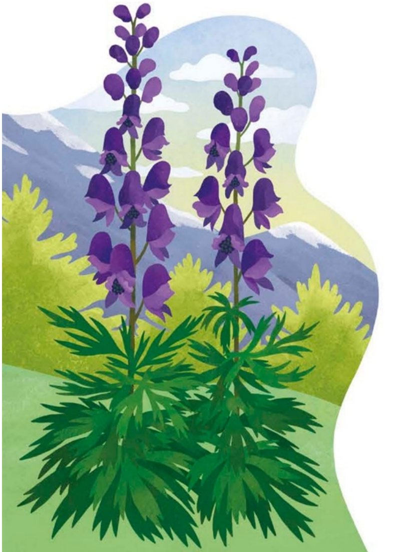
S

C

F

a

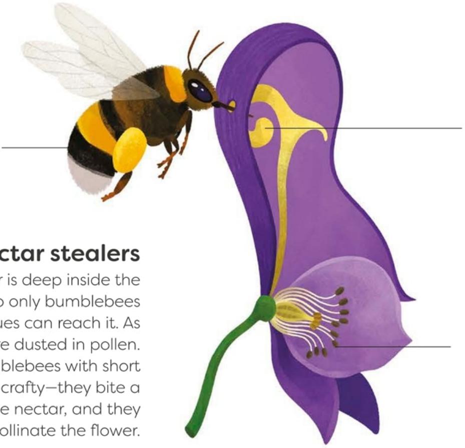
Wolfsbane



Wolfsbane

(Aconitum napellus)

Wolfsbane lives in Europe, and has a relative in North America that is also toxic. Gardeners grow both species but handle them with gloves.



Nectar stealers

Wolfsbane nectar is deep inside the flower's hood, so only bumblebees with long tongues can reach it. As they sip, they are dusted in pollen. However, bumblebees with short tongues can be crafty—they bite a hole to steal the nectar, and they don't pollinate the flower.

W

fl

w

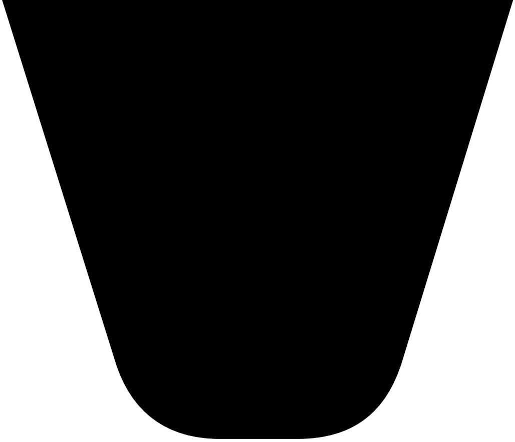
th

H

t

h

d



W

h

th

g

th

N

p

p

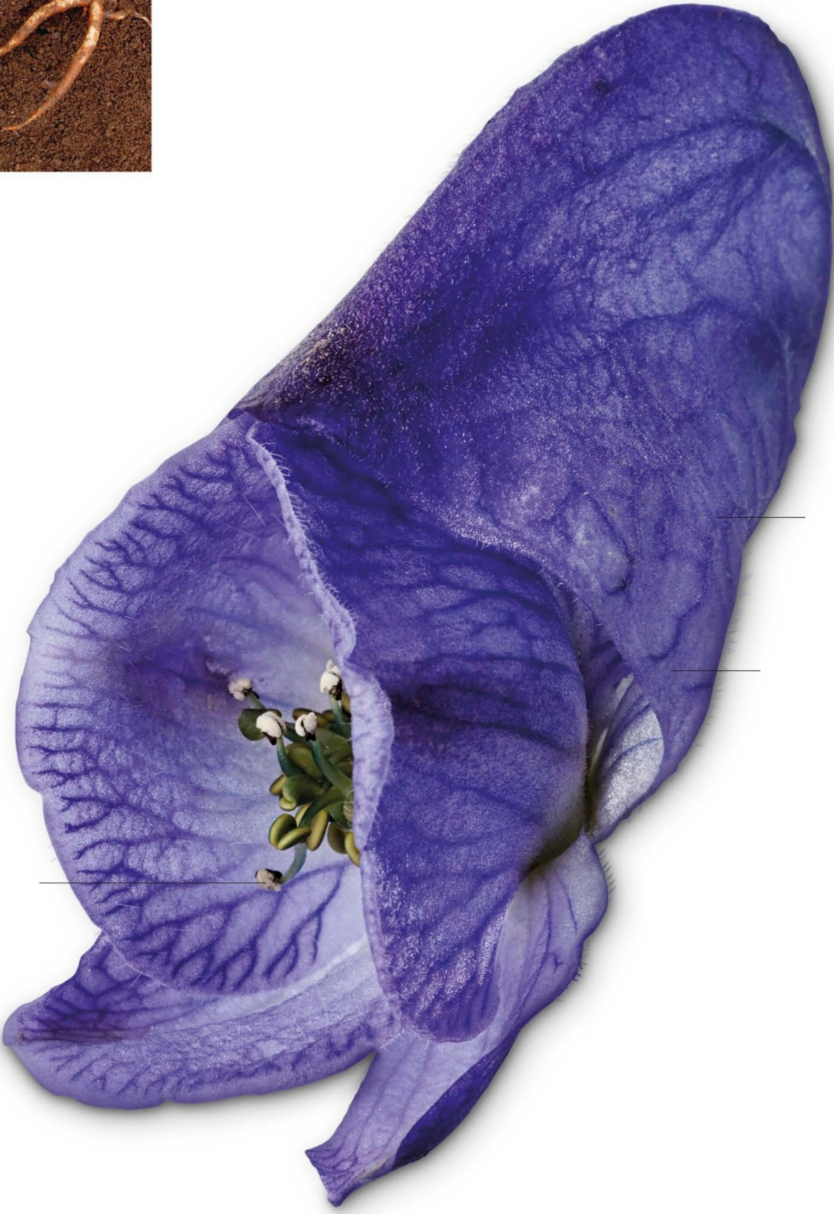
A

p

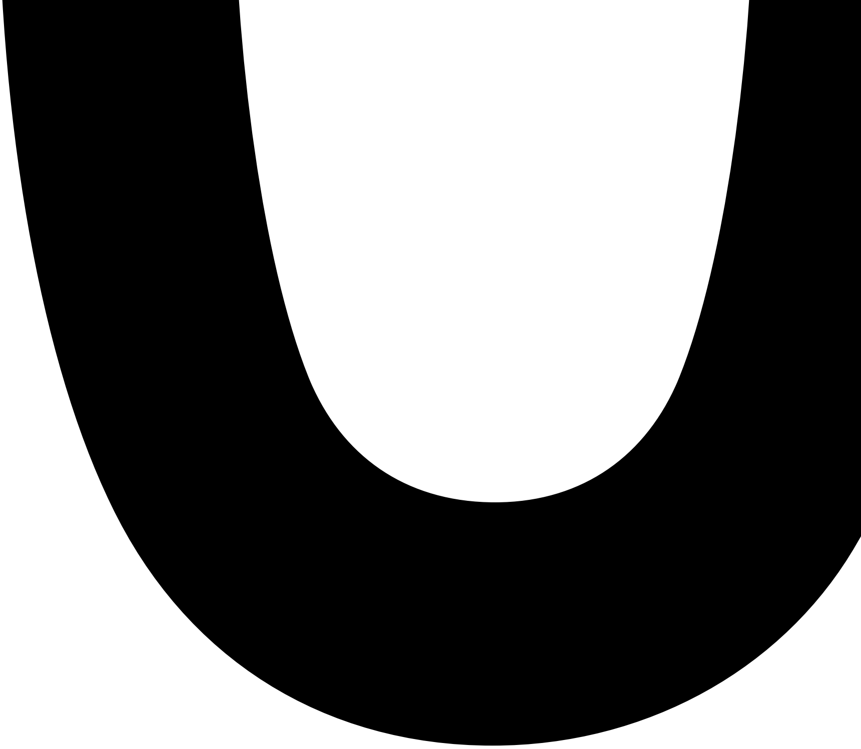
S

t

WOL



12



[redacted]

W

m

h

C

T

O

lo

re

th

T

d

Vi

M

S

t

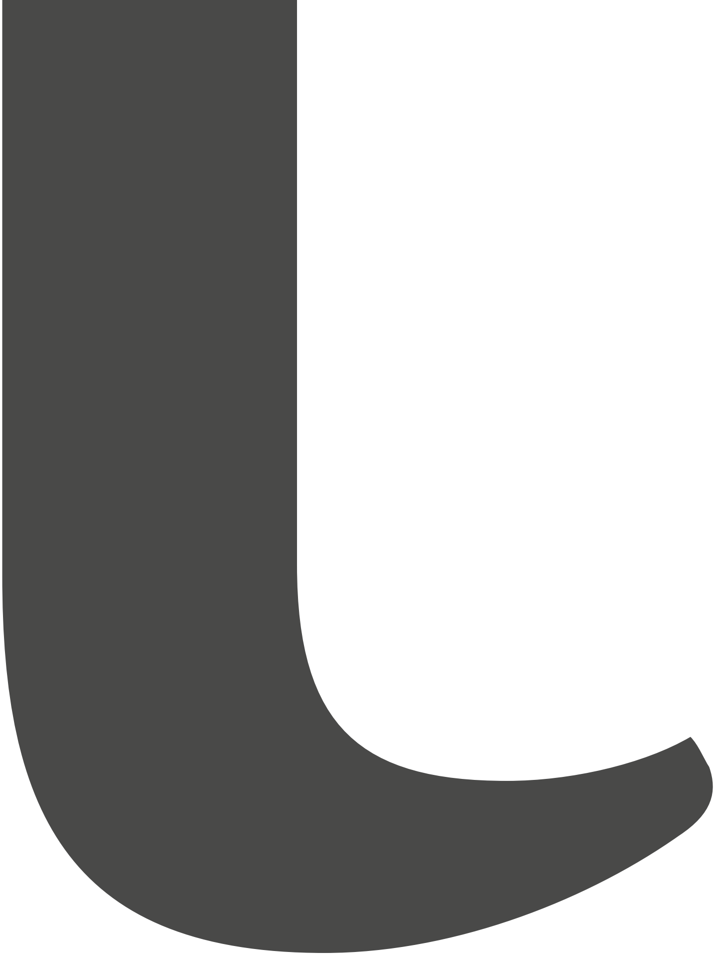
p

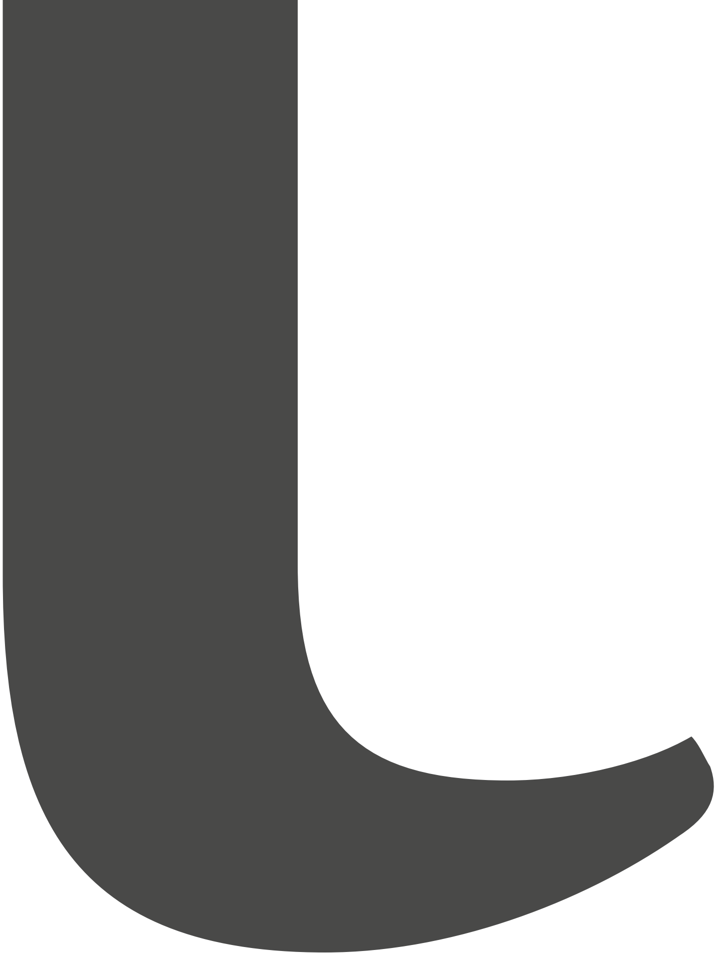
C

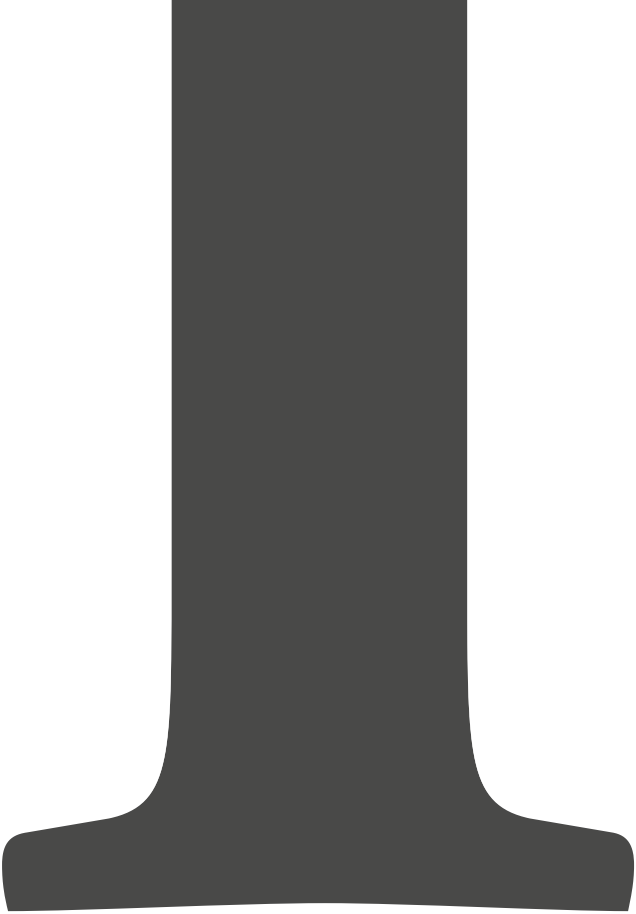
th

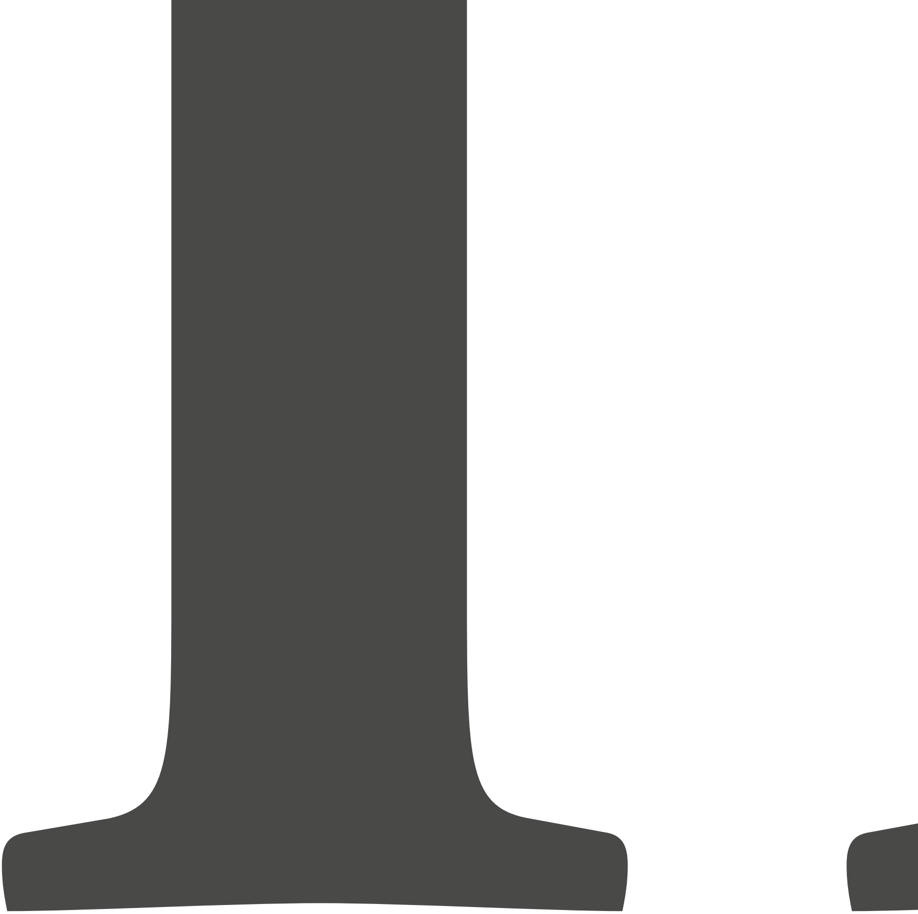
C

J

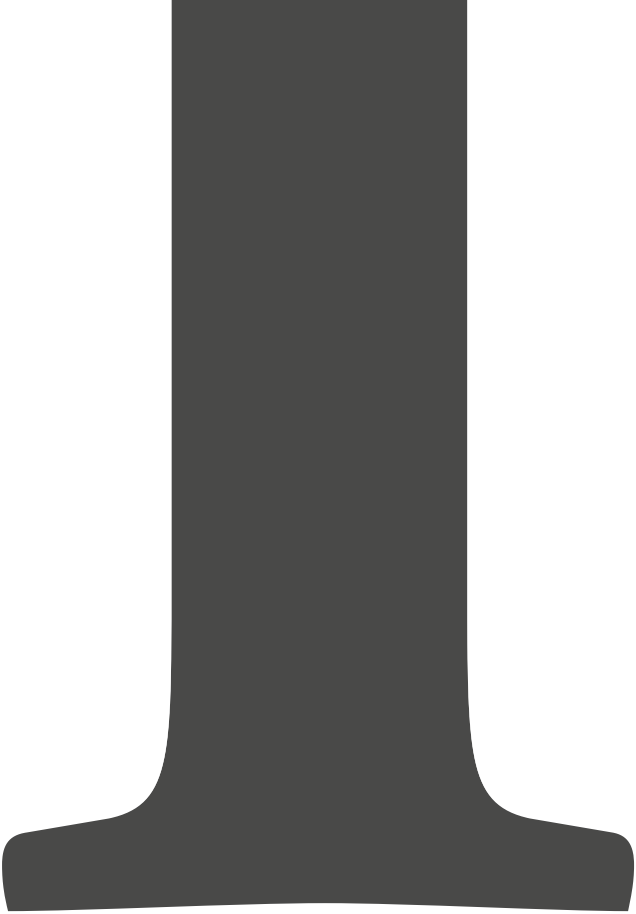


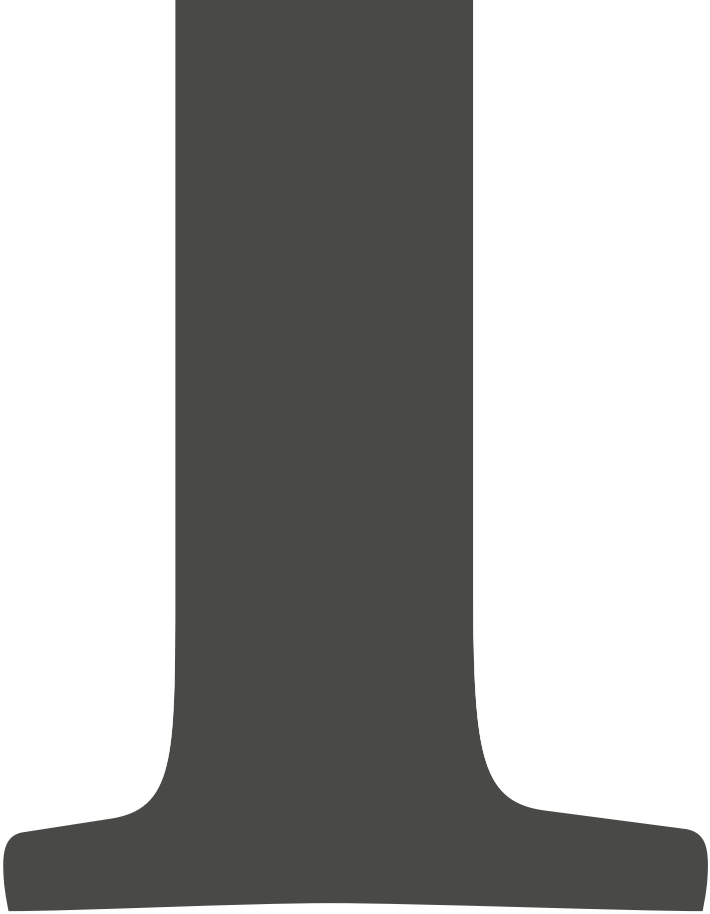


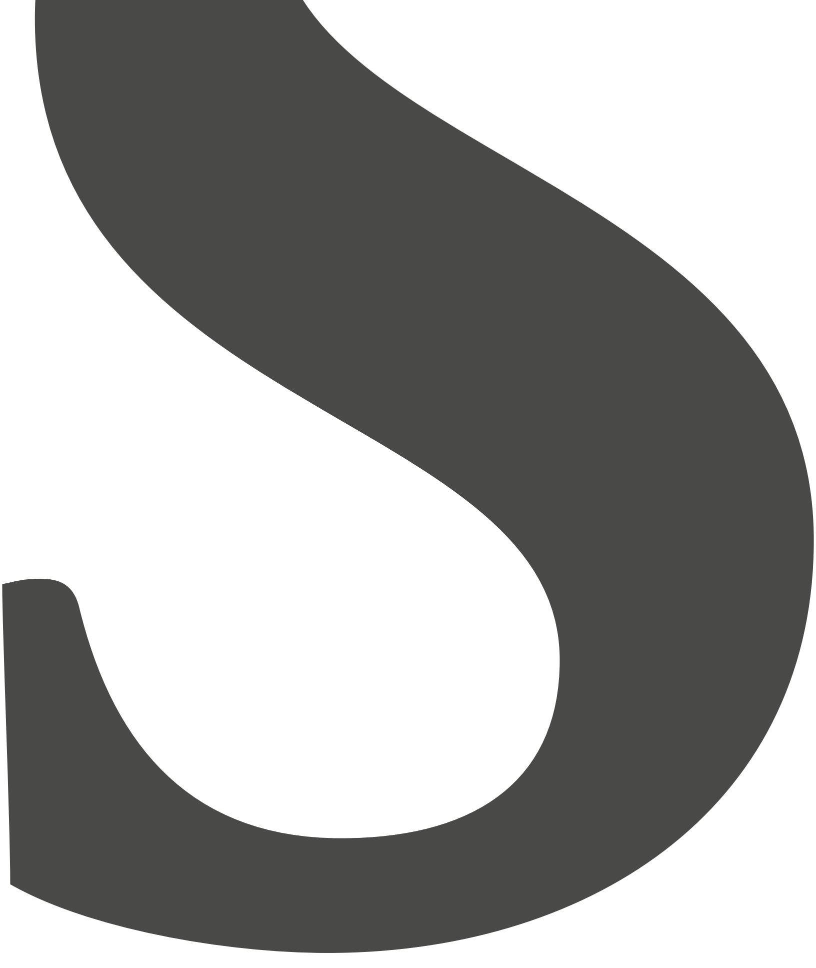


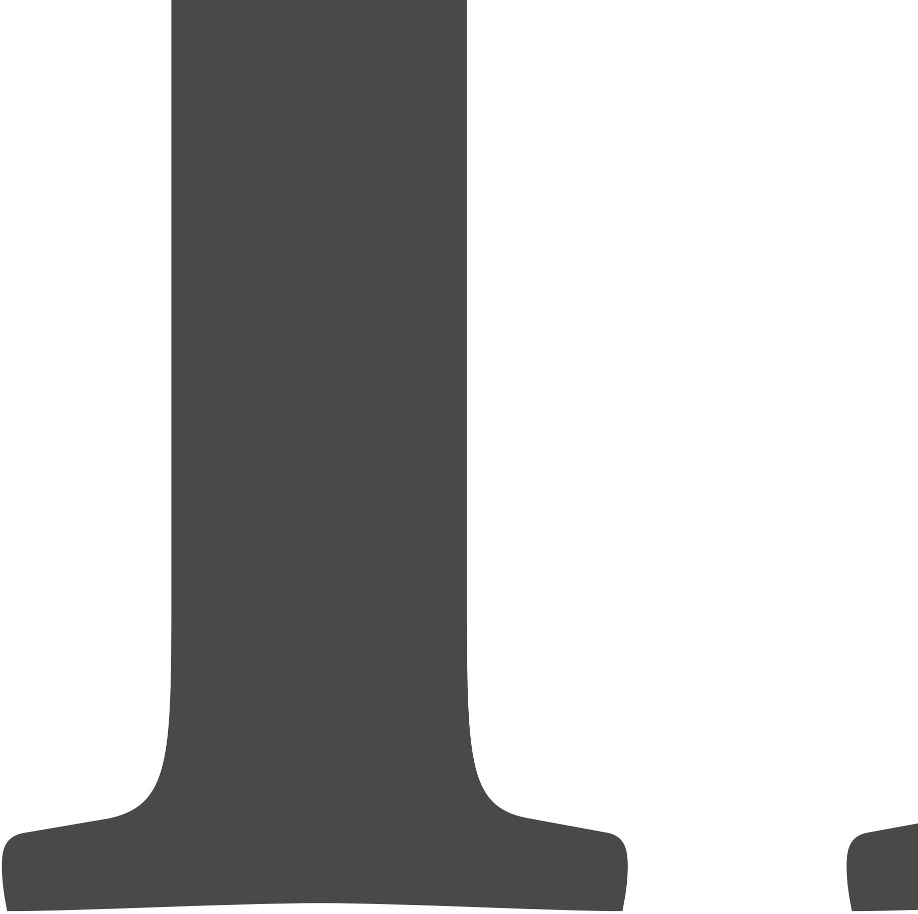


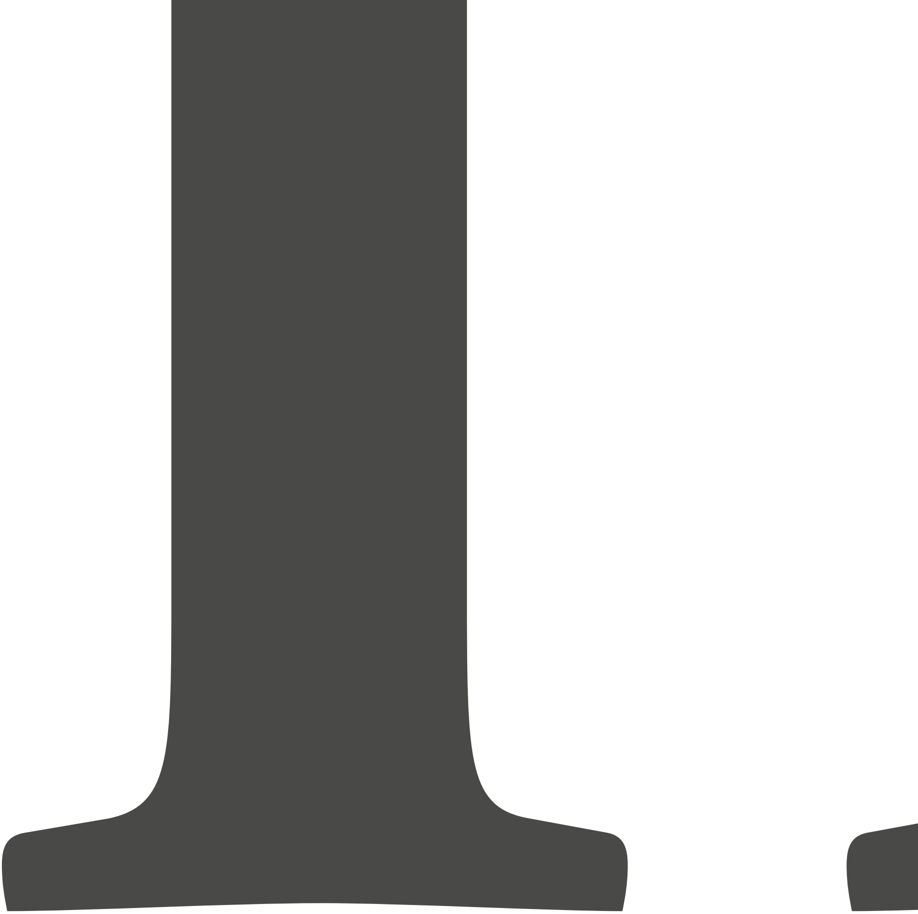
V

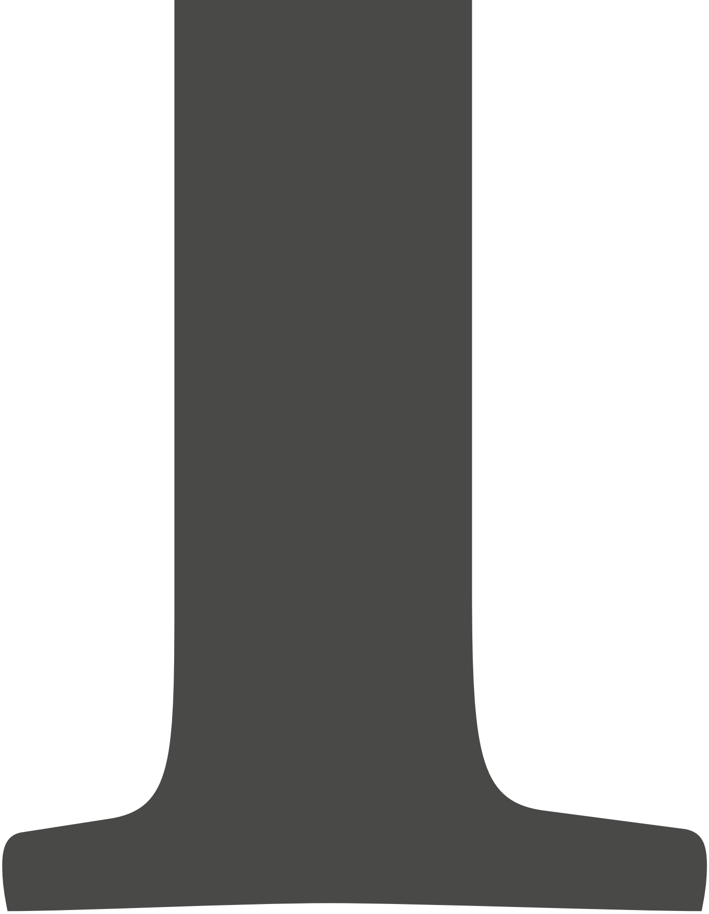


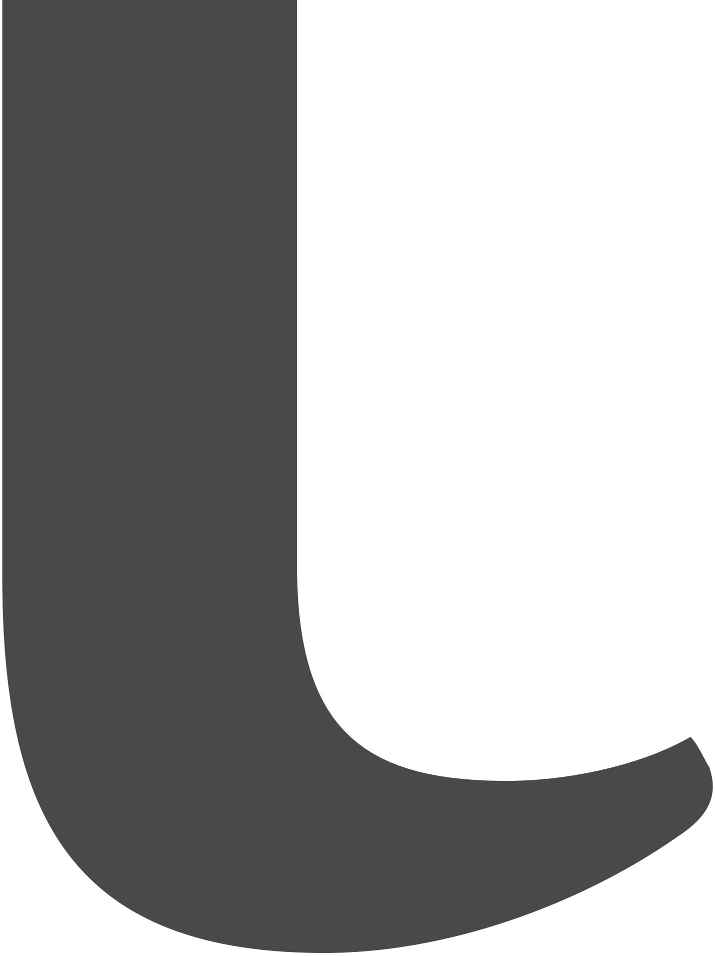


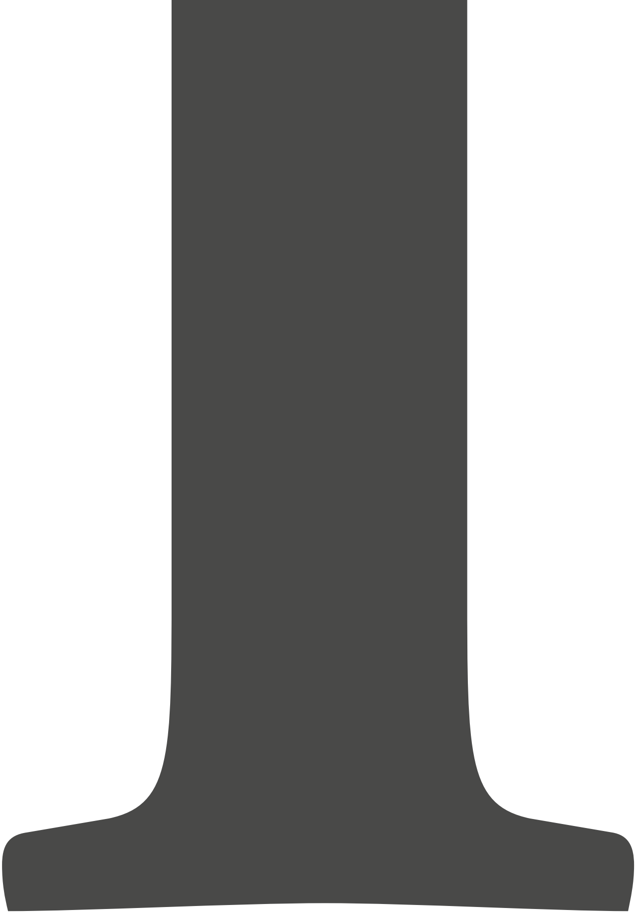


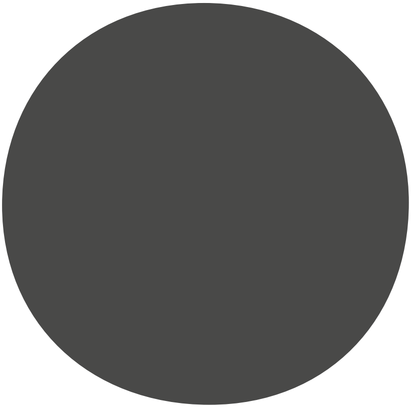










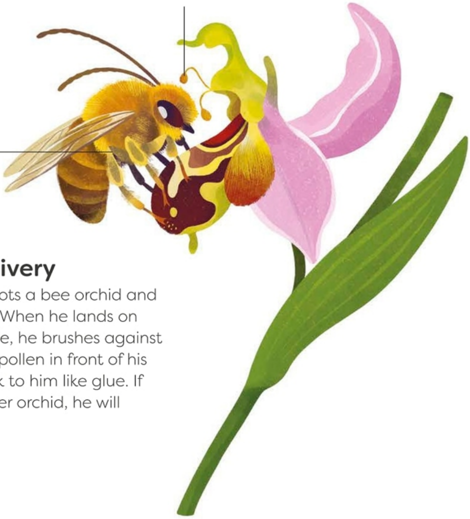


Th

m

se

lik



Pollen delivery

A male bee spots a bee orchid and flies toward it. When he lands on the fake female, he brushes against small blobs of pollen in front of his face. They stick to him like glue. If he visits another orchid, he will pollinate it.

12

A

fl

th

sr

f

h

p

F

p

e

m

p

T

T

lik

W

fl

a

P

L

b

R

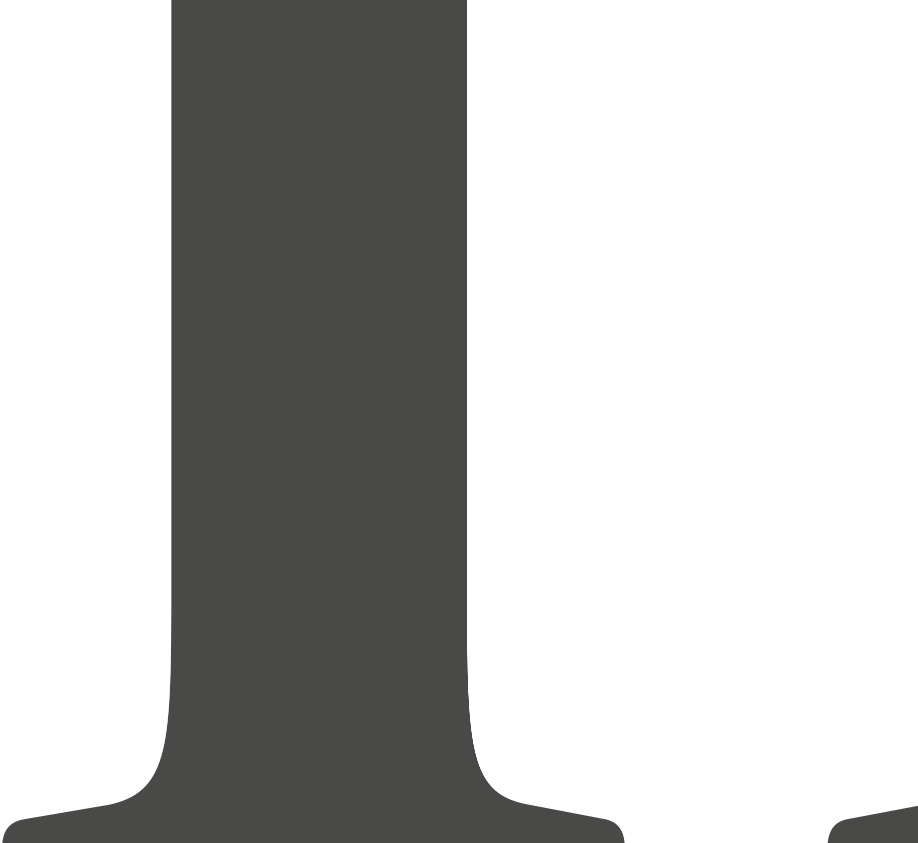
fo

of

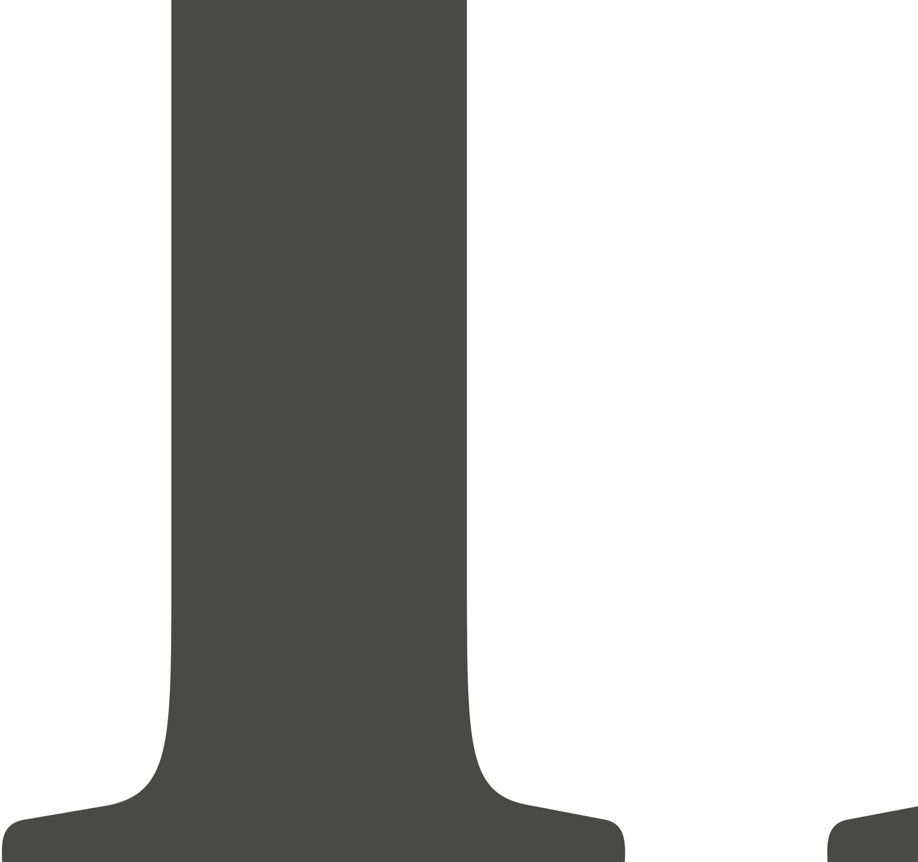
T

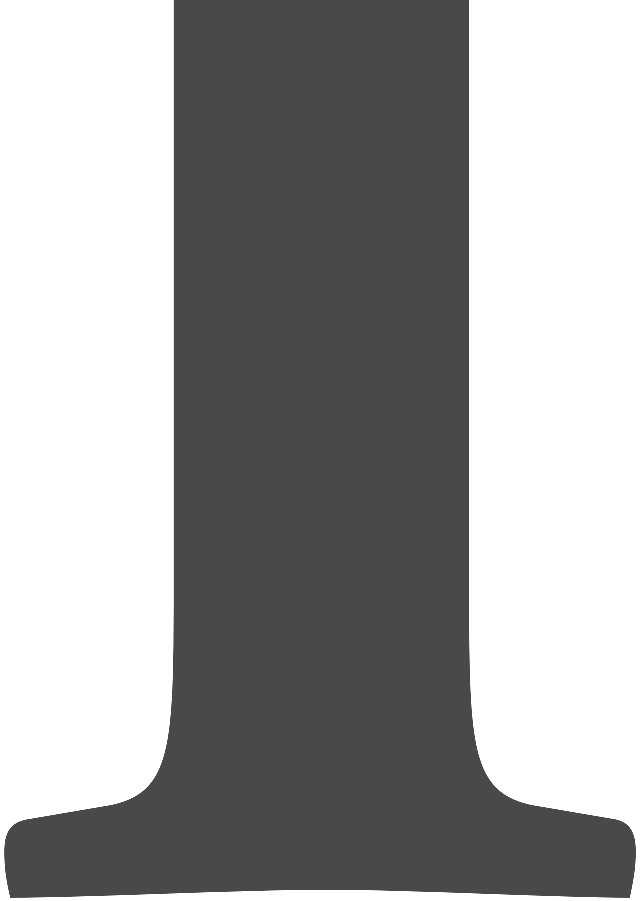
C

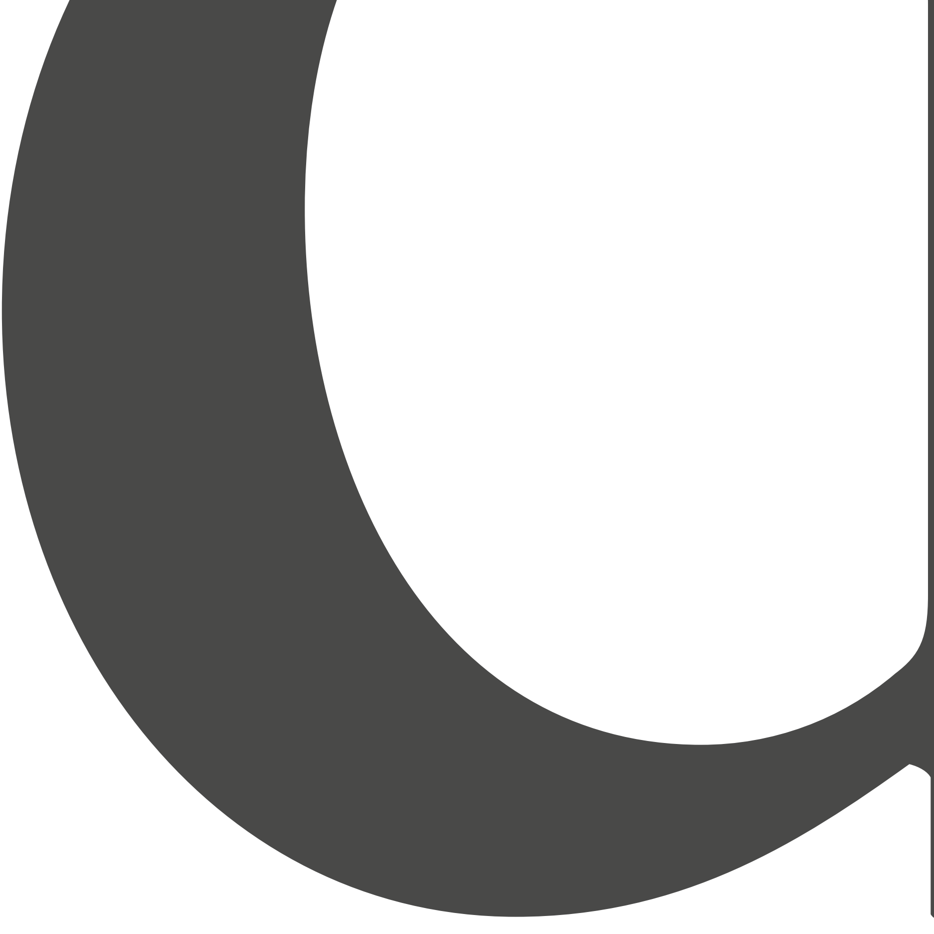
lik

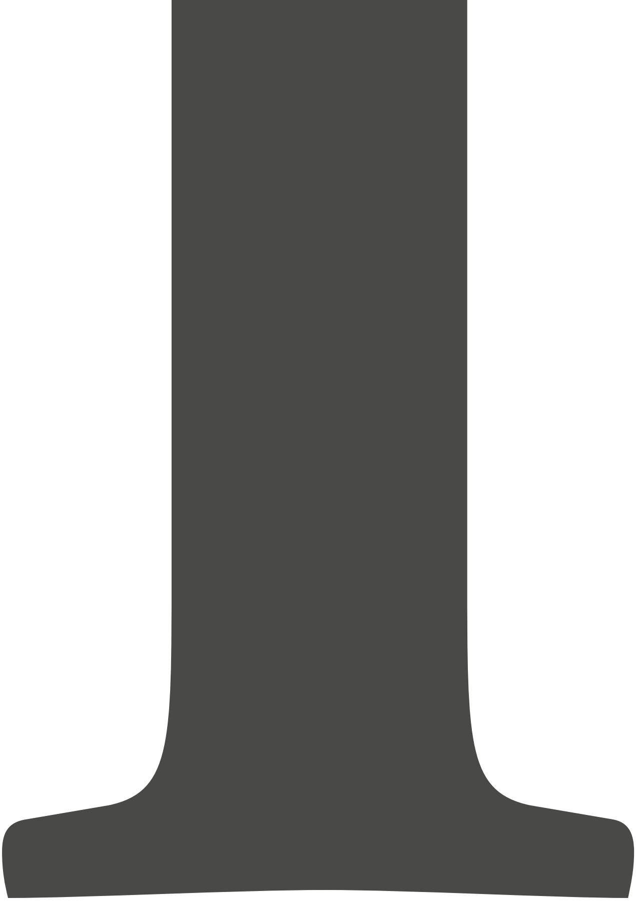


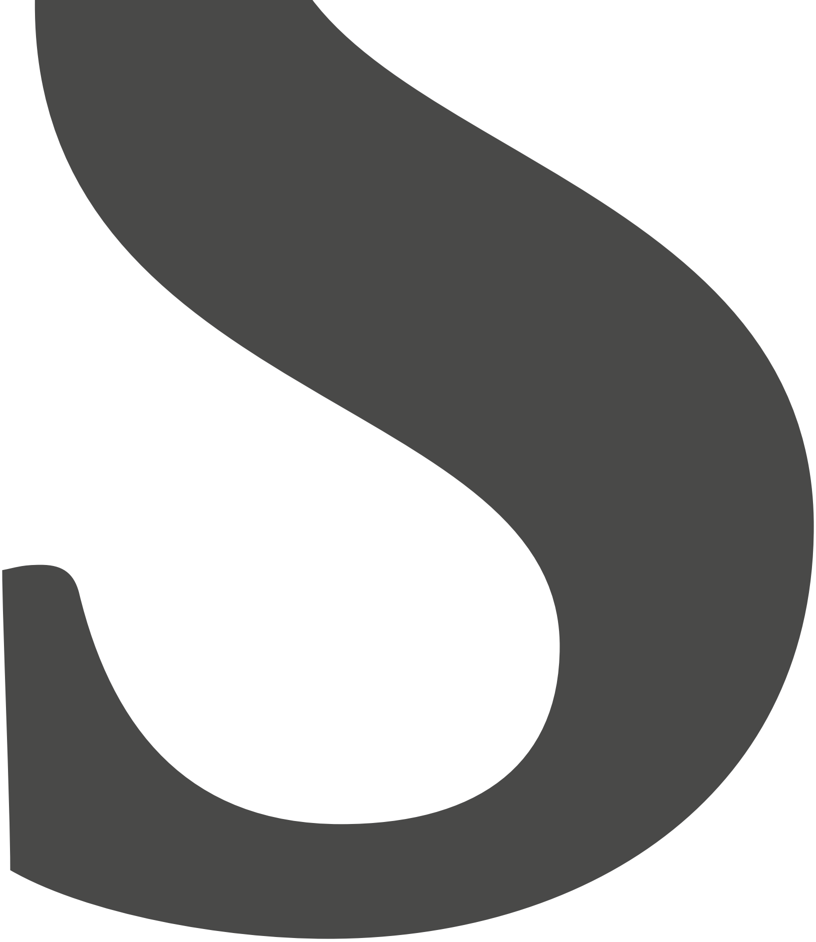
1



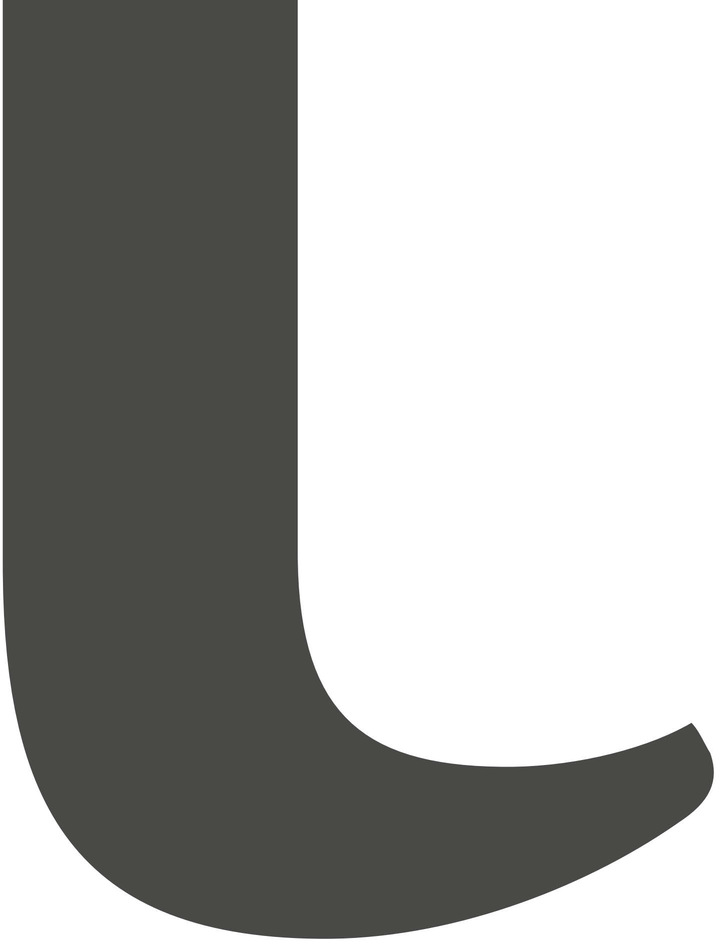


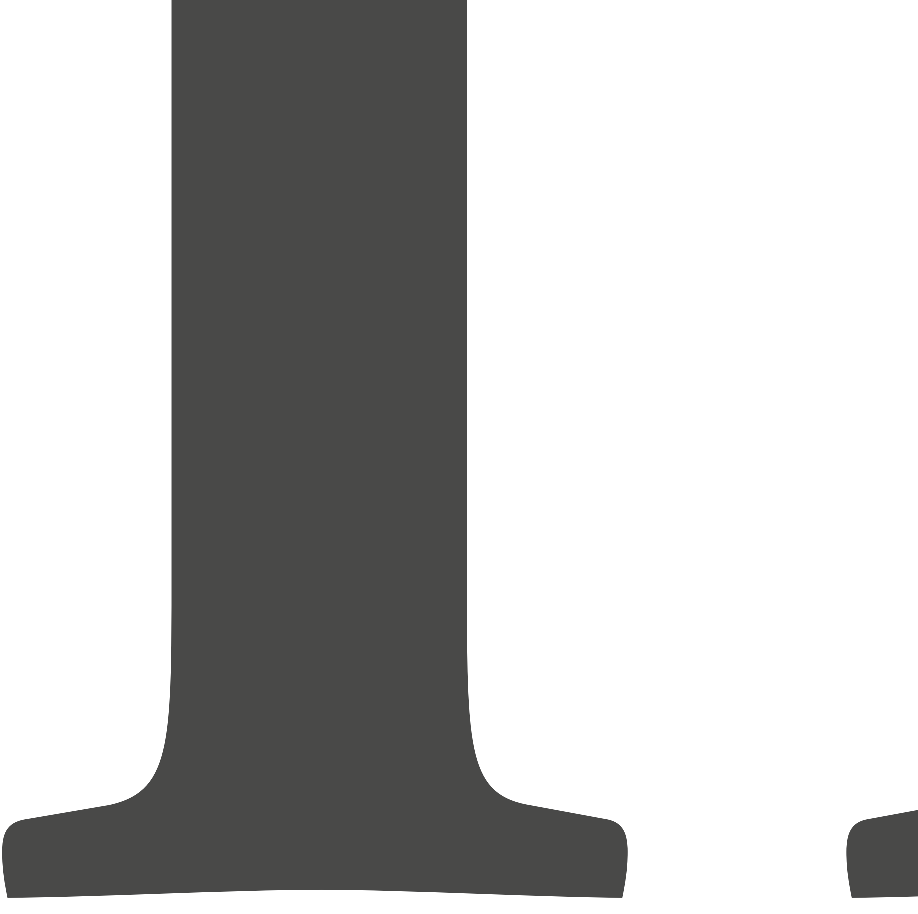


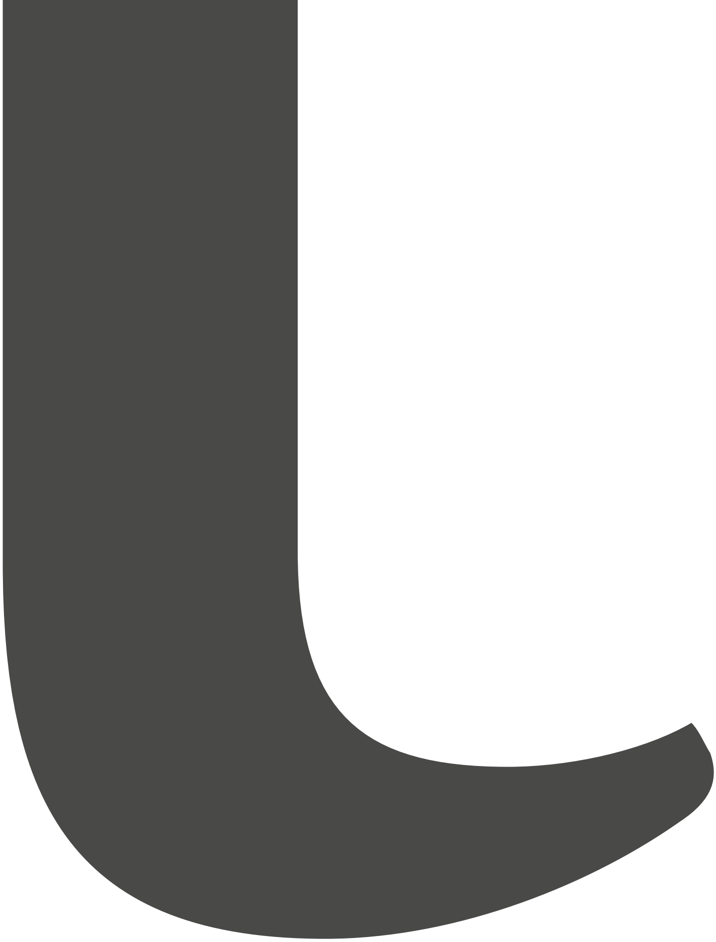




y

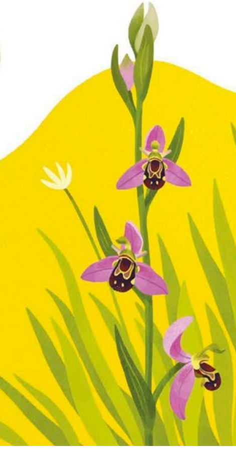






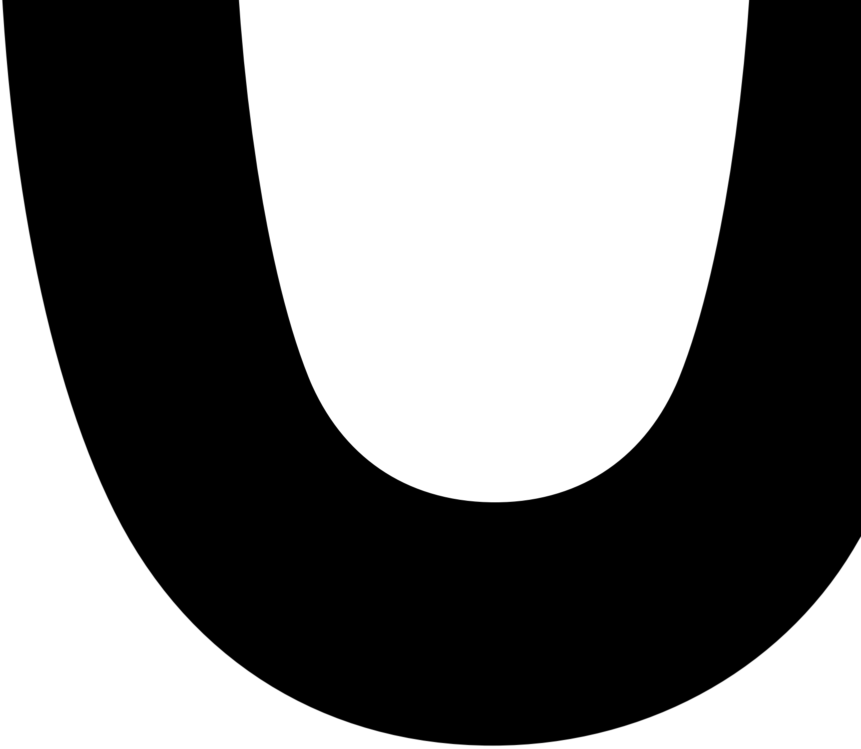
●

Bee orchid

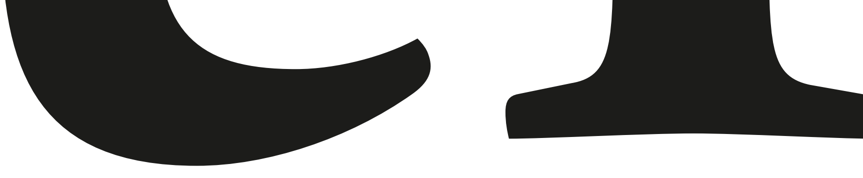


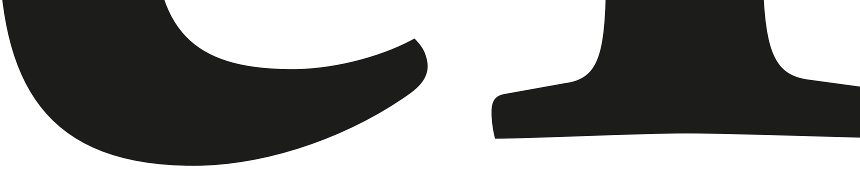
Bee orchid
(Ophrys apifera)
This orchid is found in grassy places in Europe and northern Africa, often on roadsides or empty lots.

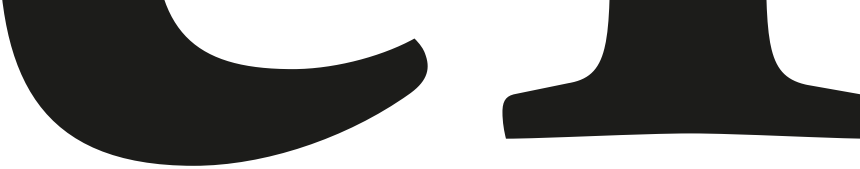
L



[redacted]







T

p

A

e

L

st

a

Copycat plants

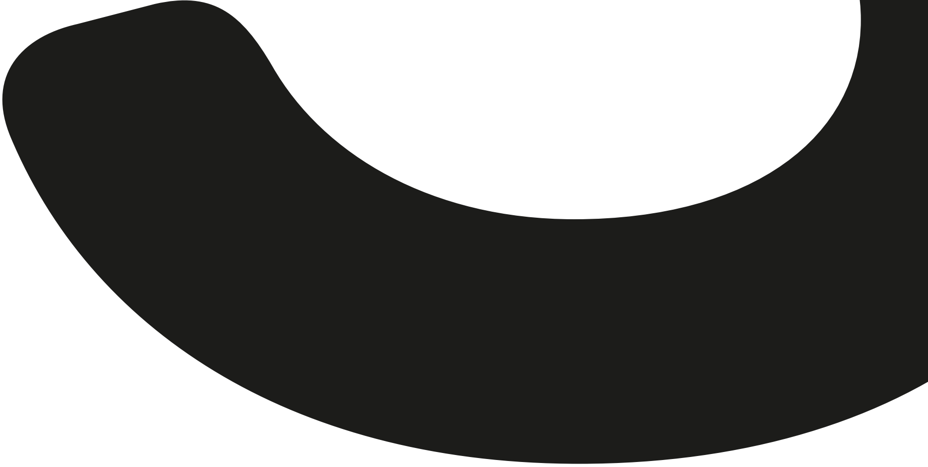
12

T

h

h

e



T

th

th

Vi

it

T

S

th

fe

C

T

fl

fr

m

p

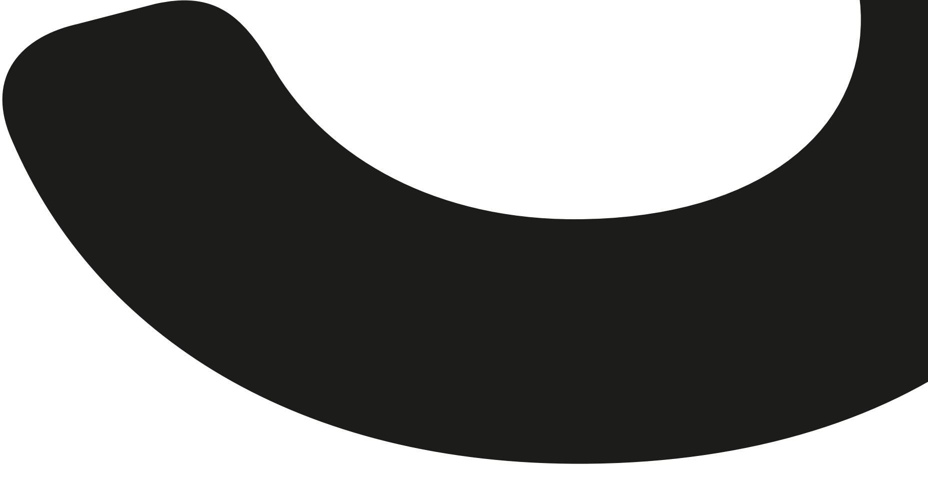
T

th

b

e

a



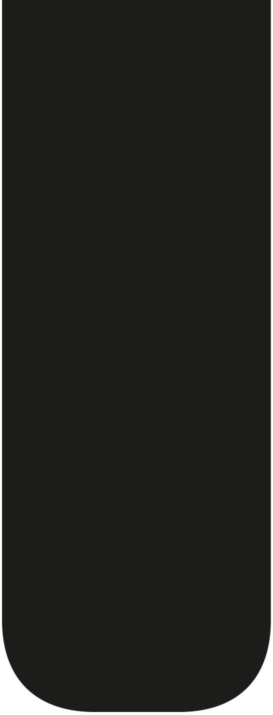
T

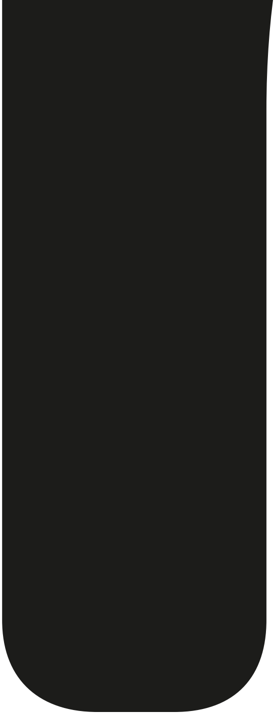
th

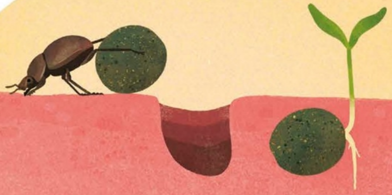
d

b

it



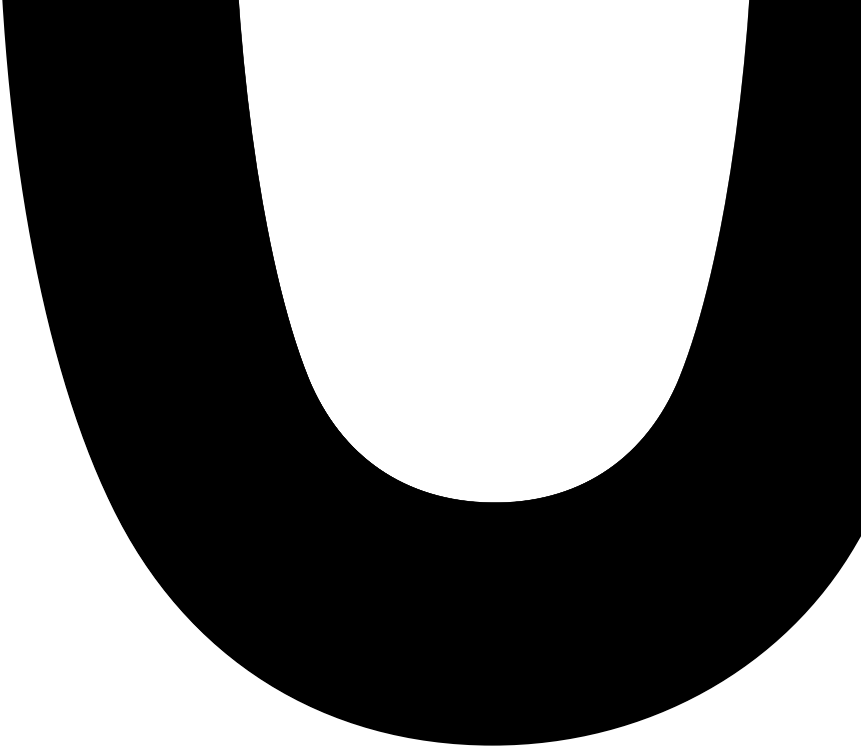




Insect gardener

One grasslike plant tricks dung beetles into planting its seeds, which look and smell like balls of antelope poo! The beetles think they have found the perfect food for their grubs, so they roll the seeds away and bury them, only for them to sprout.

12



[redacted]

[redacted]

Y

th

st

a

h

T

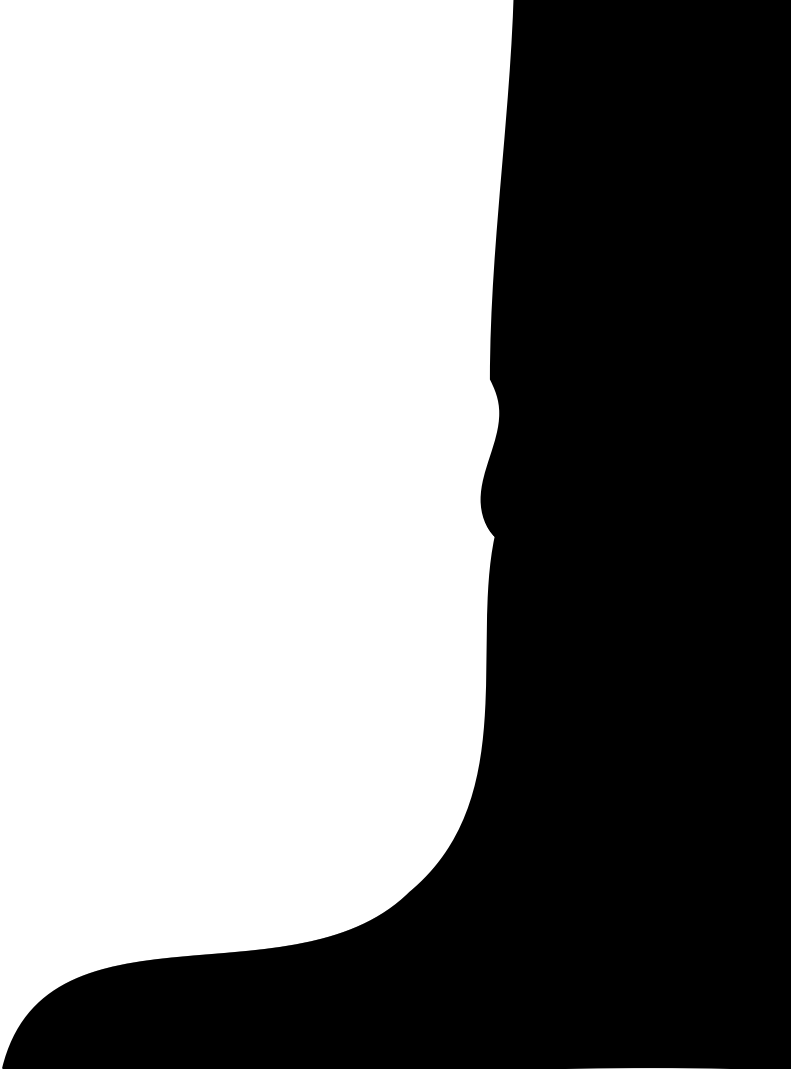
b

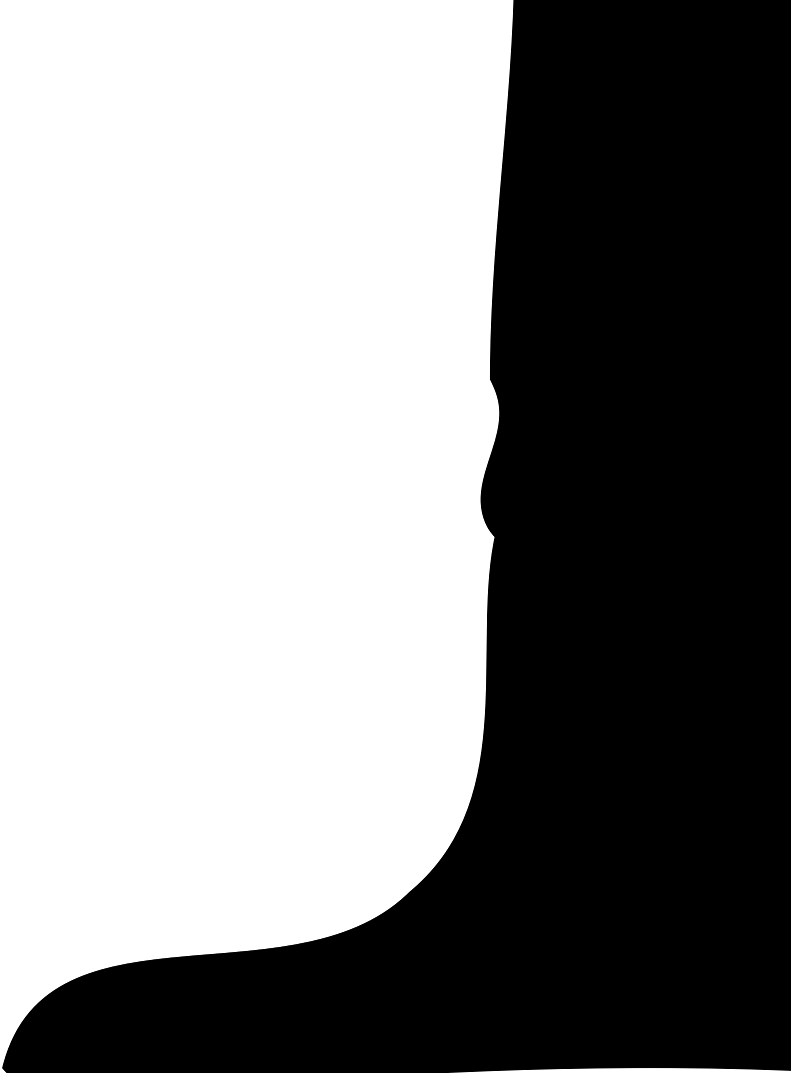
n

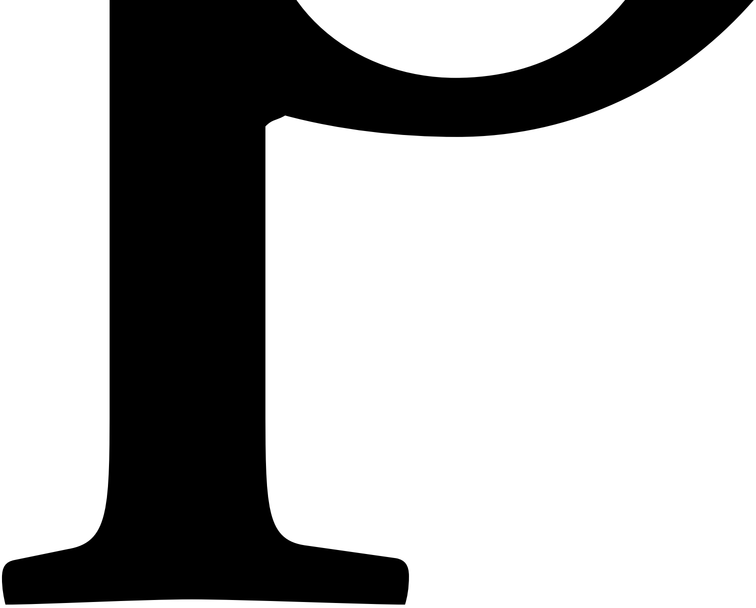
SU

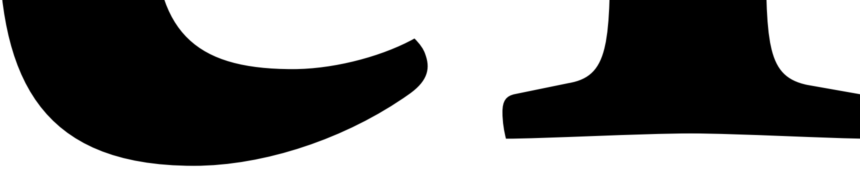
th

th









T

sh

sl

ye

b

T

sr

a

ju

12

T

th

its

p

T

e

p

F

p

b

th

a

th

T

d

d

p

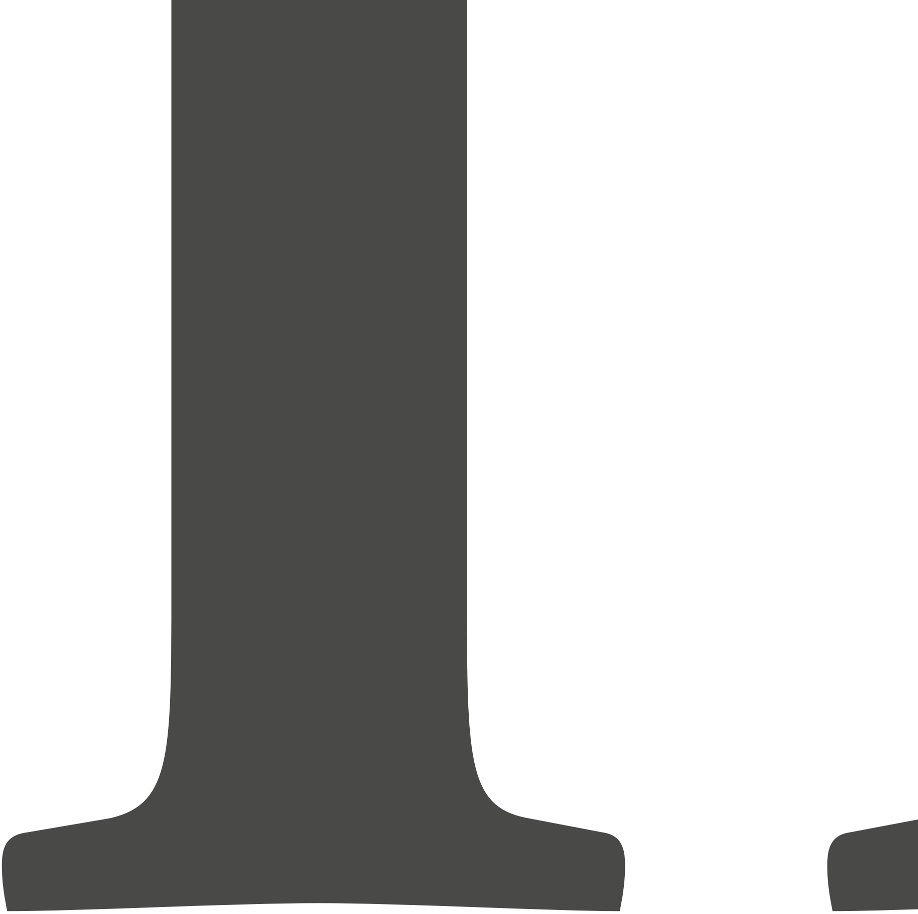
f

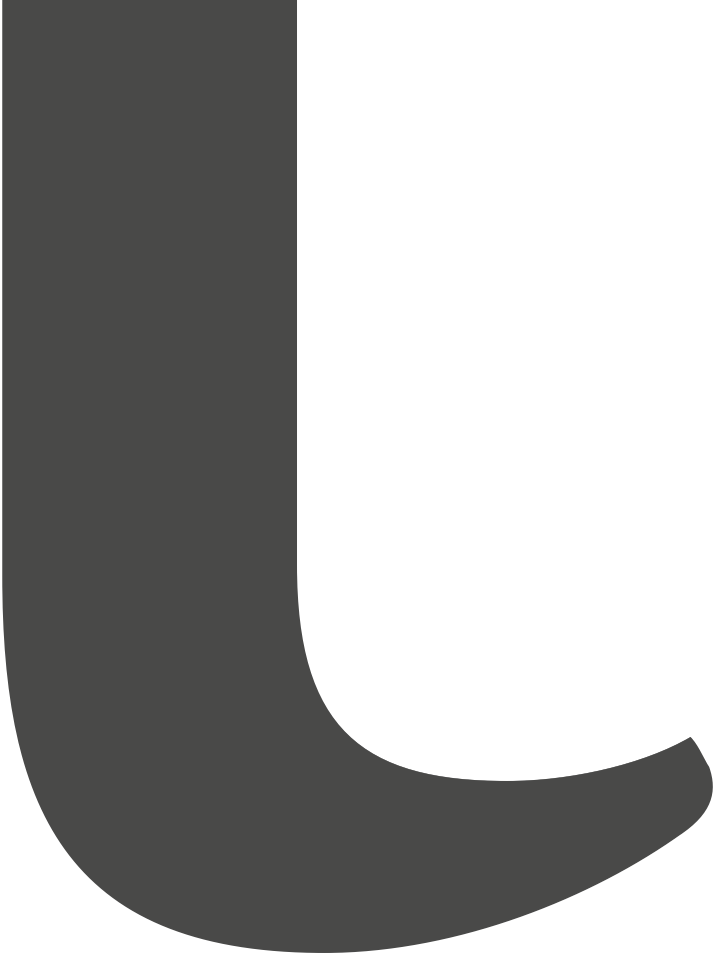
C

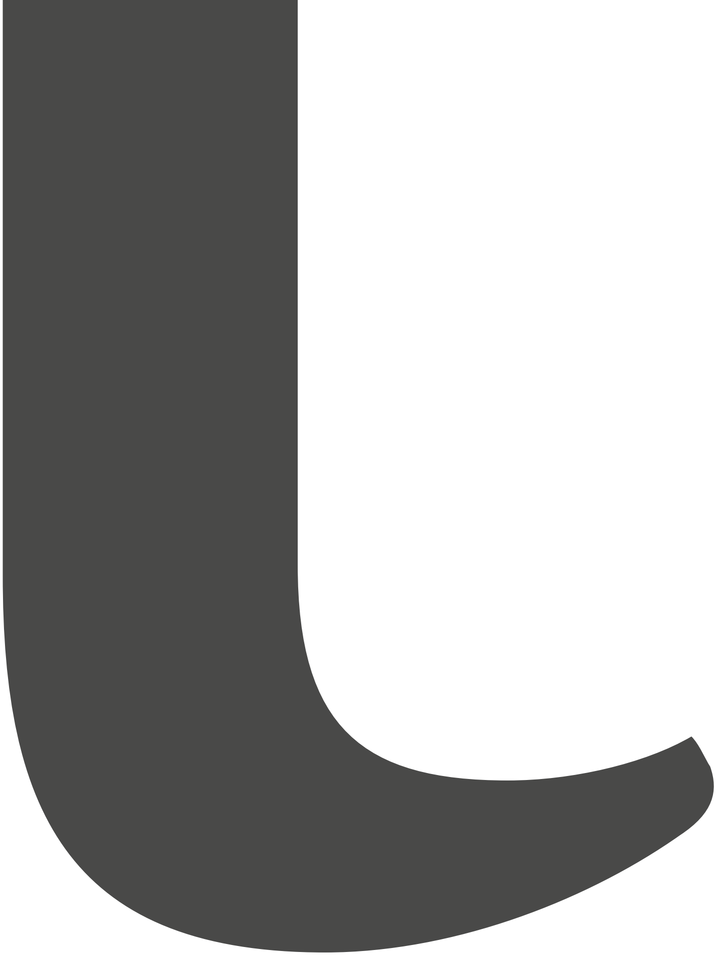
G

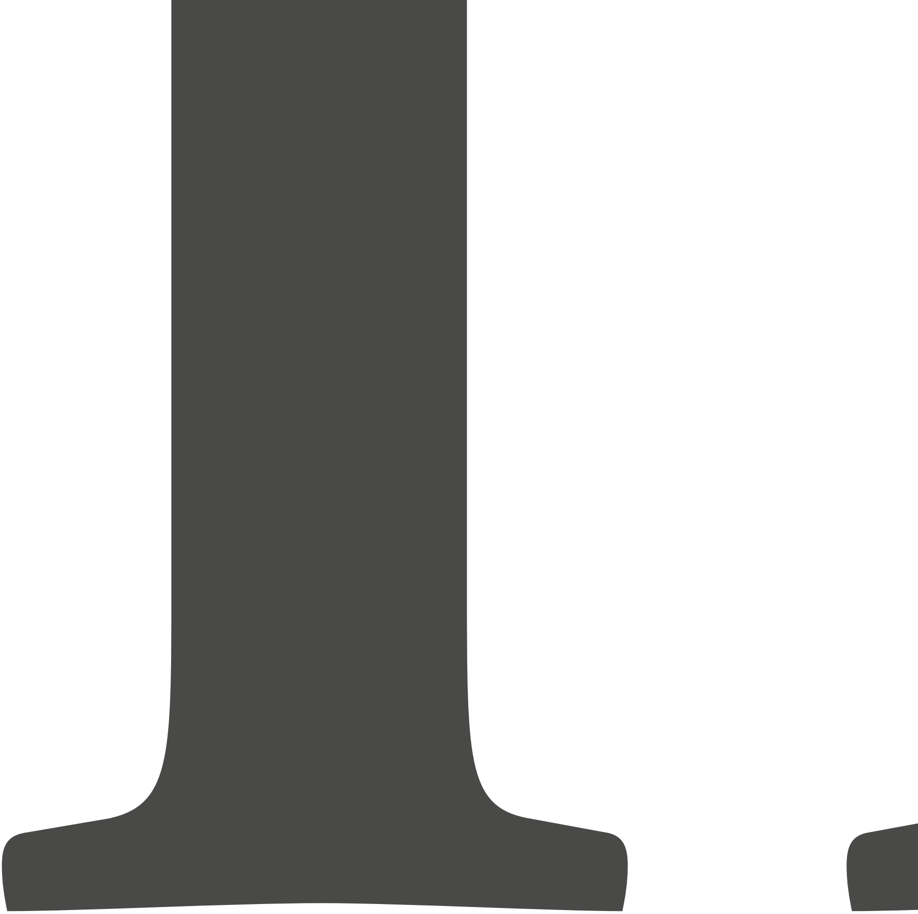
se

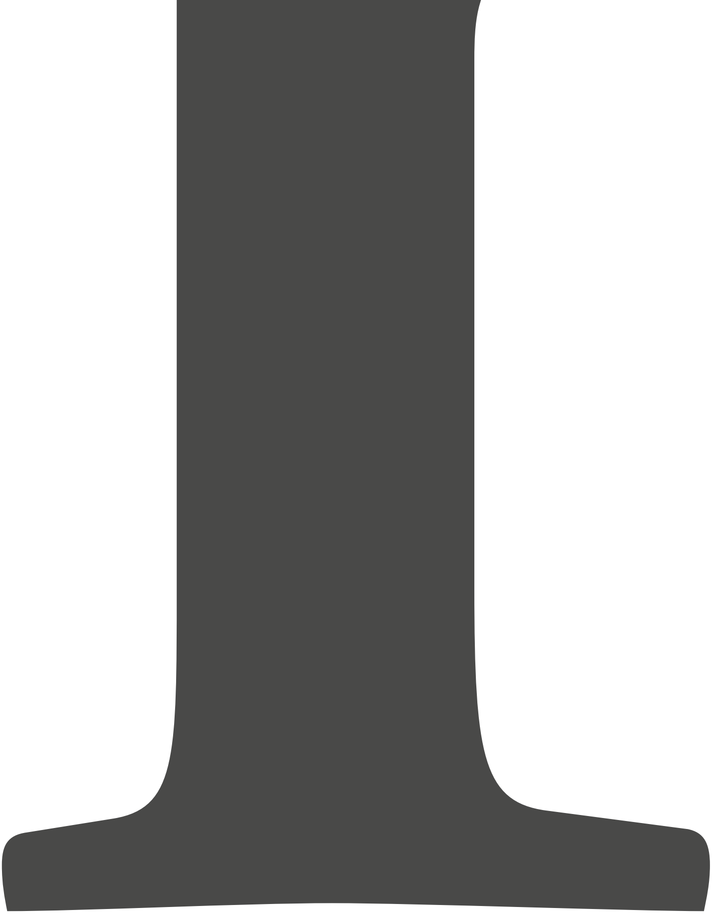
th

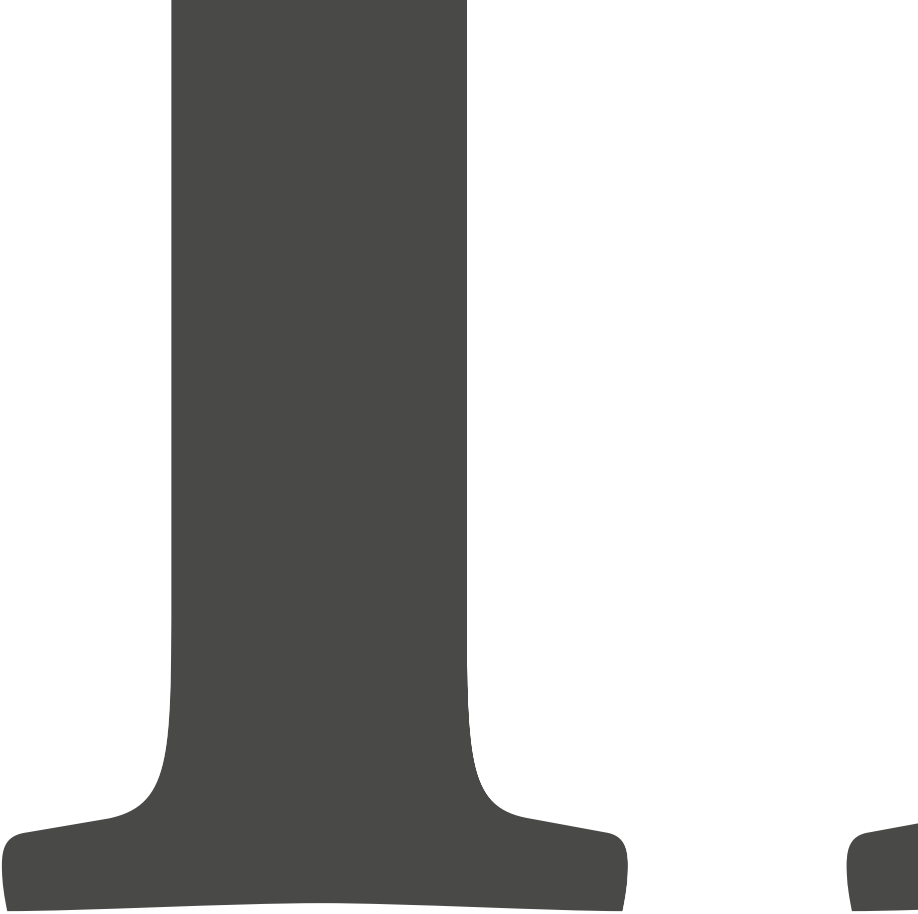


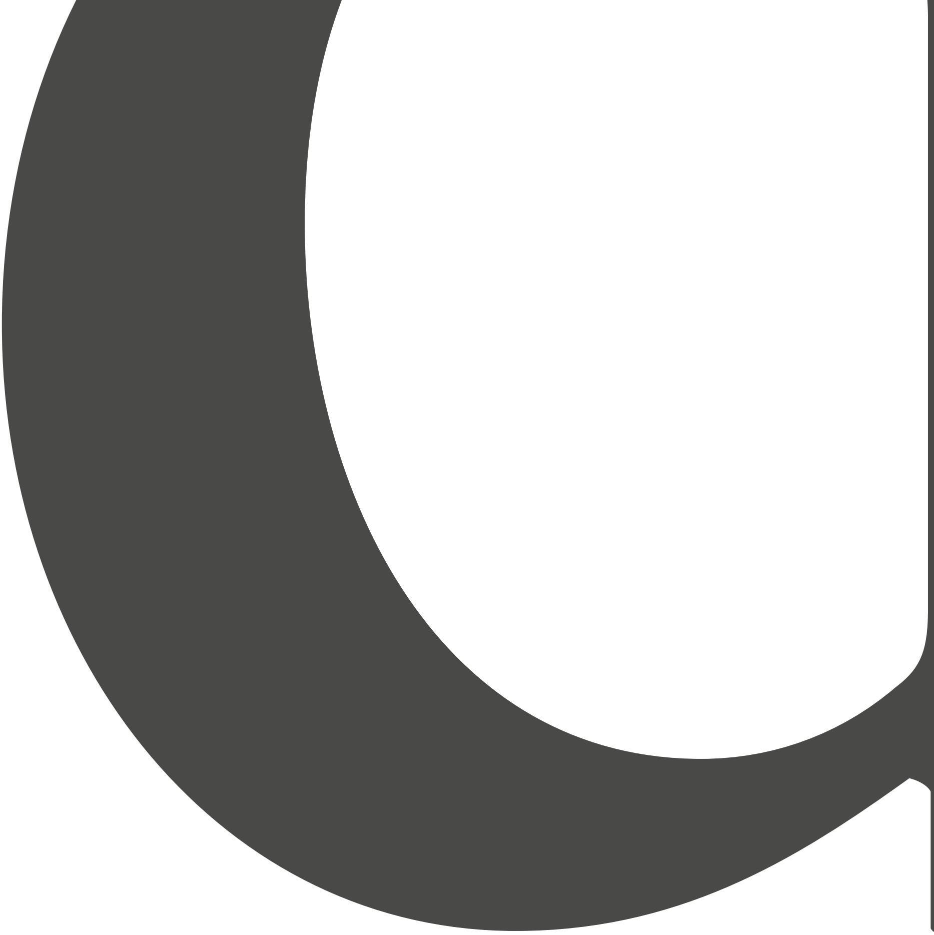




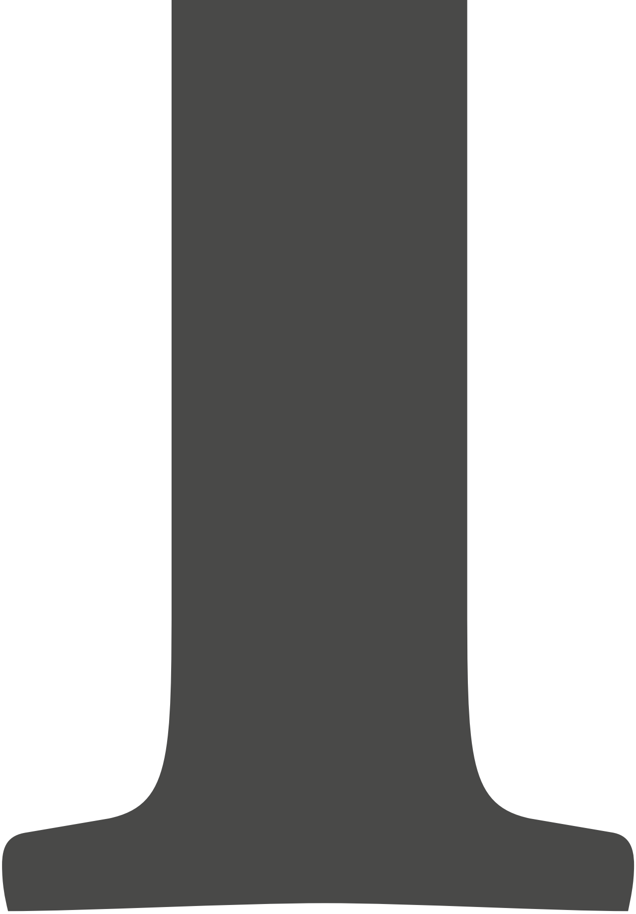


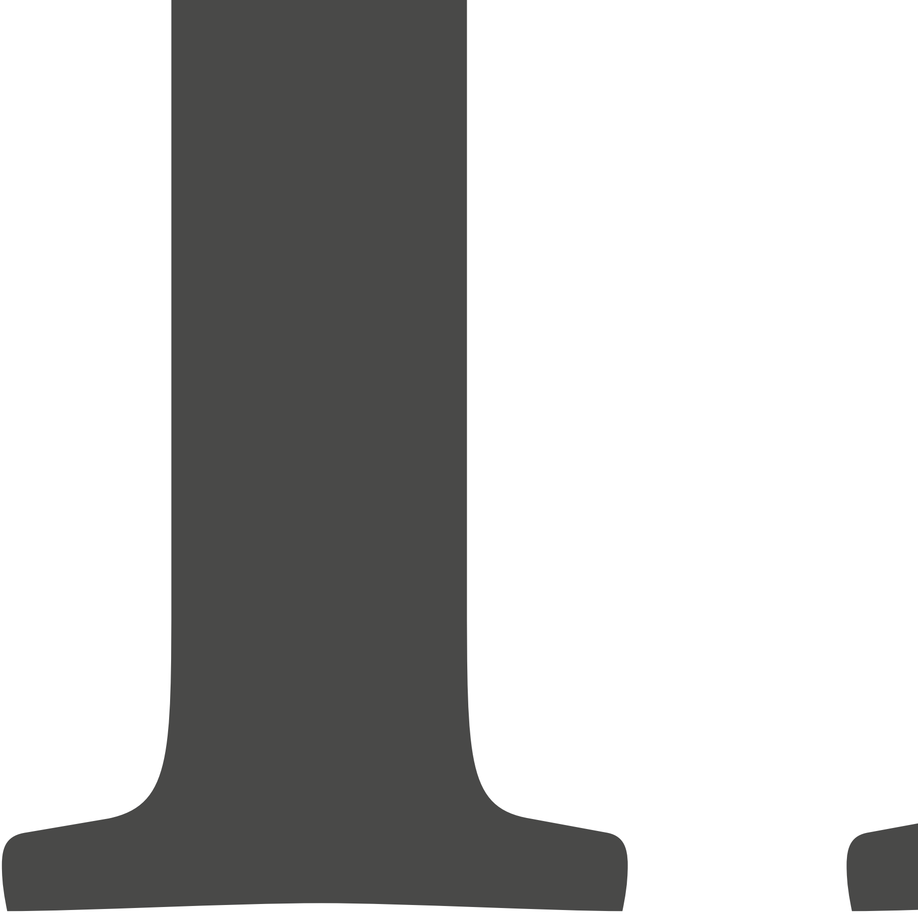


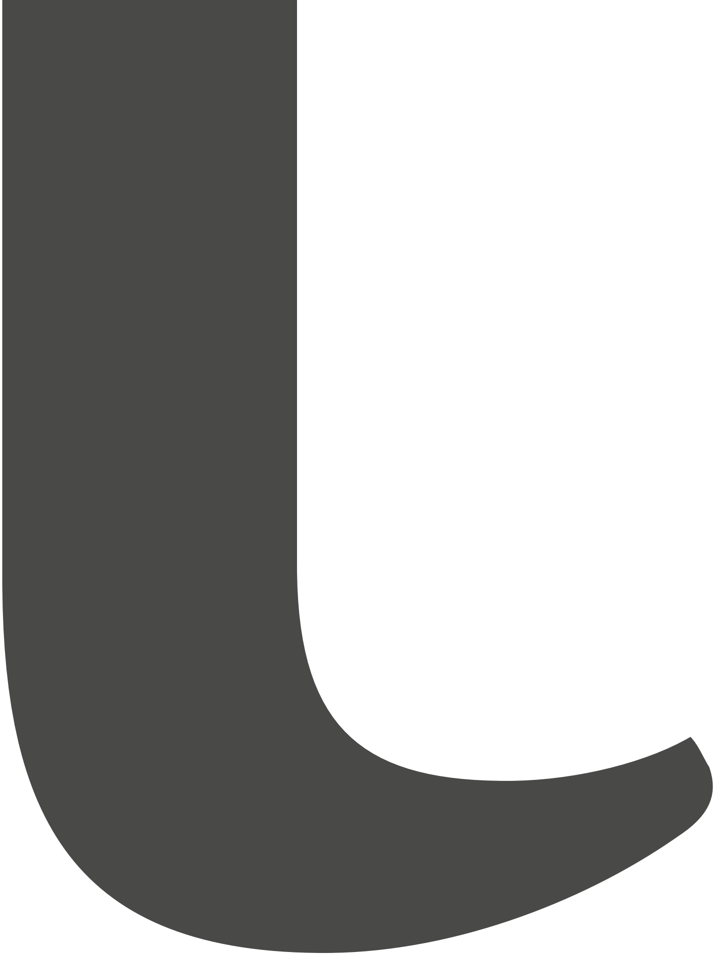




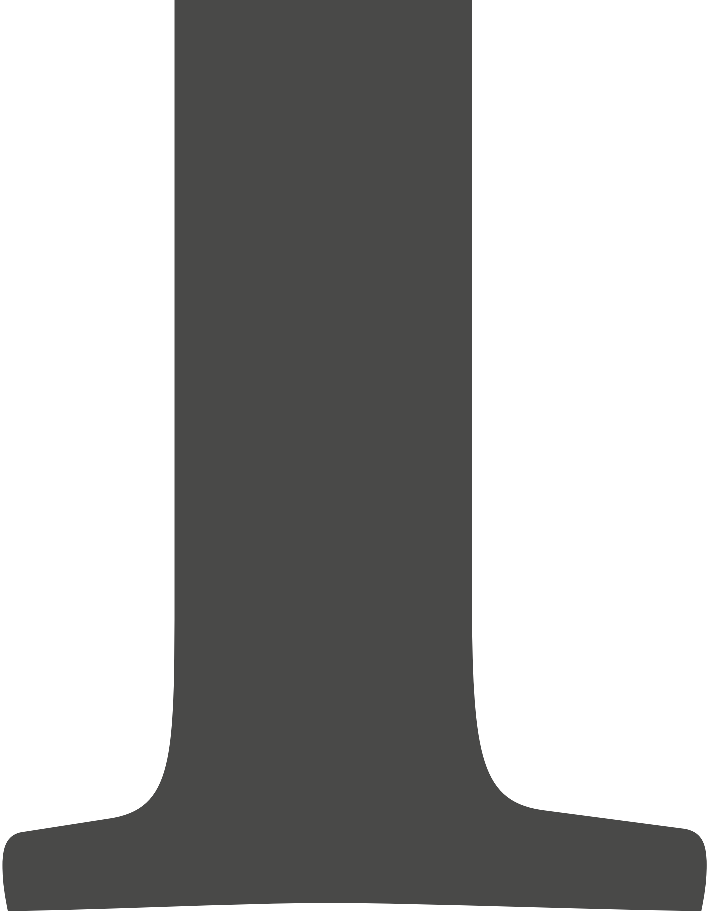
S

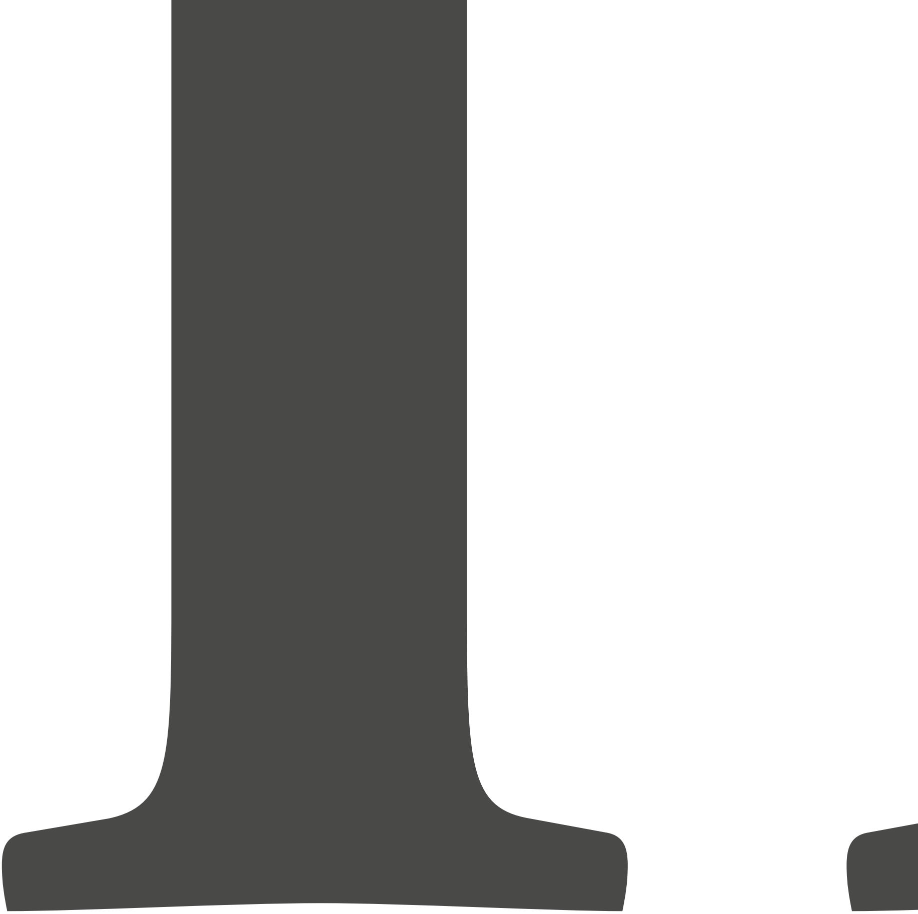


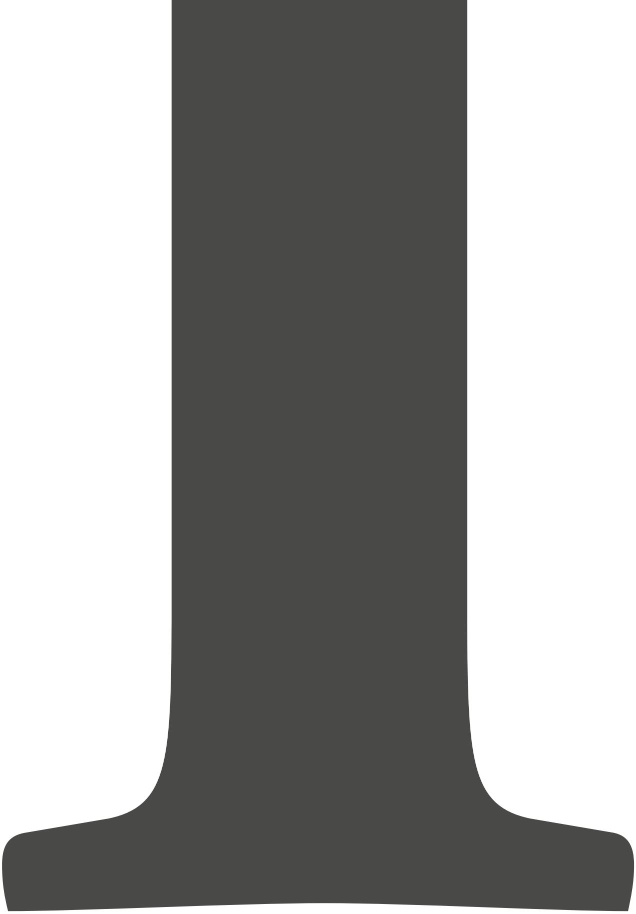


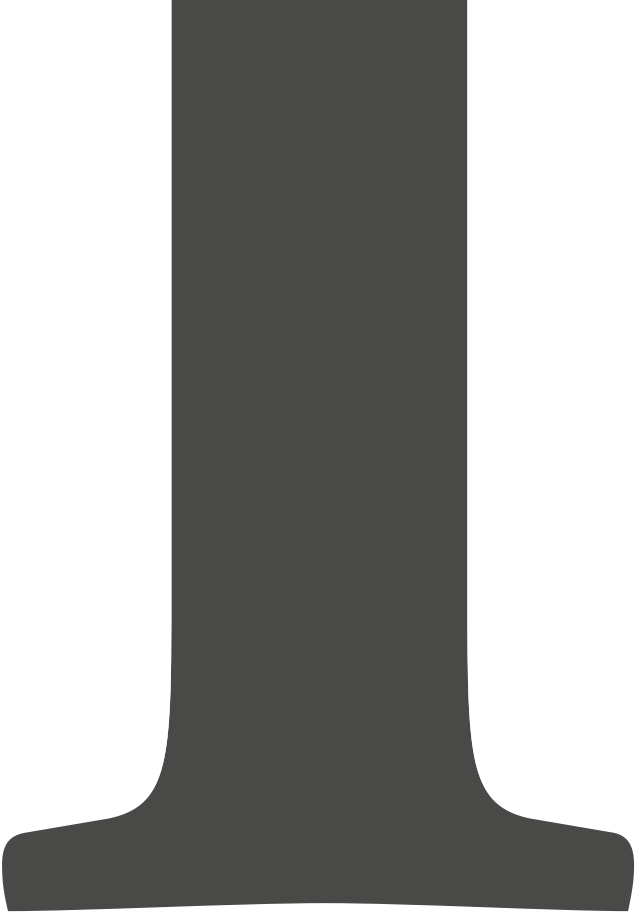


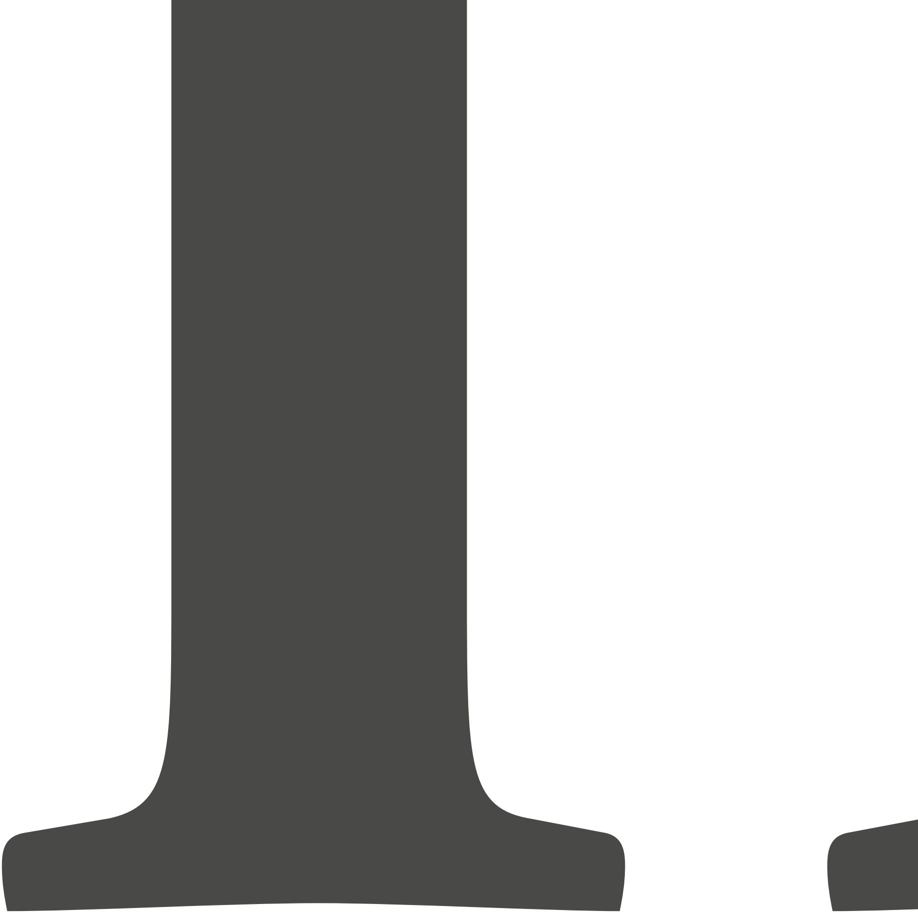
y

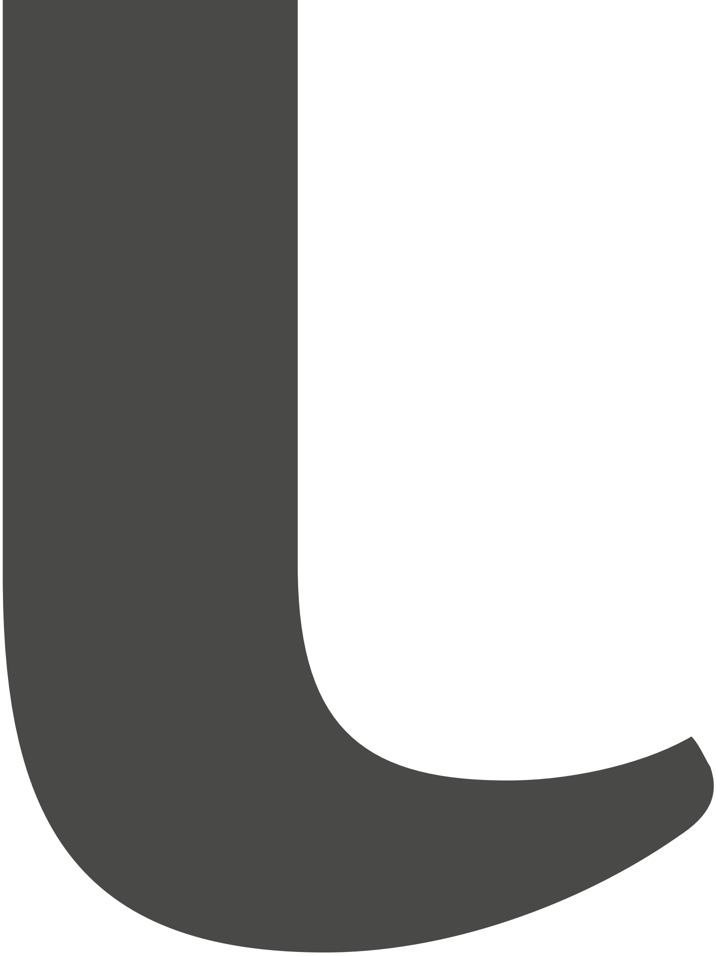


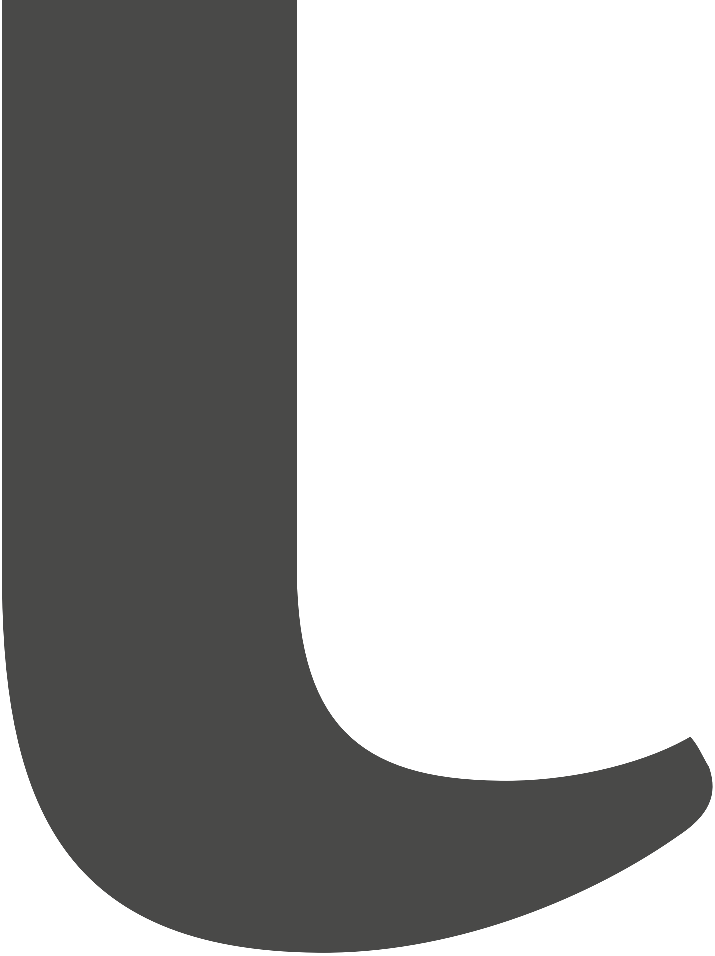


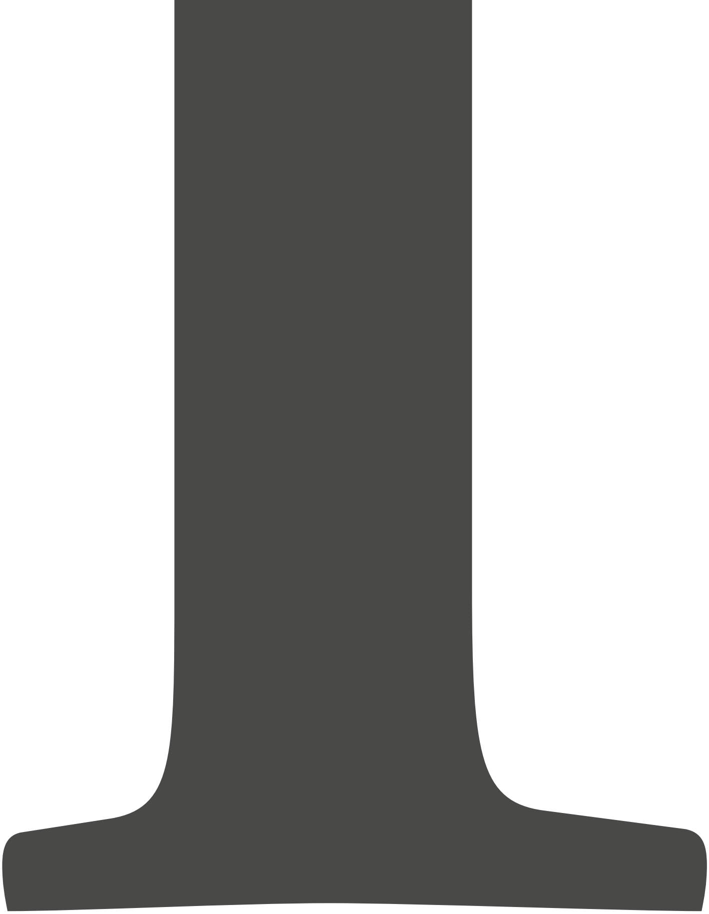


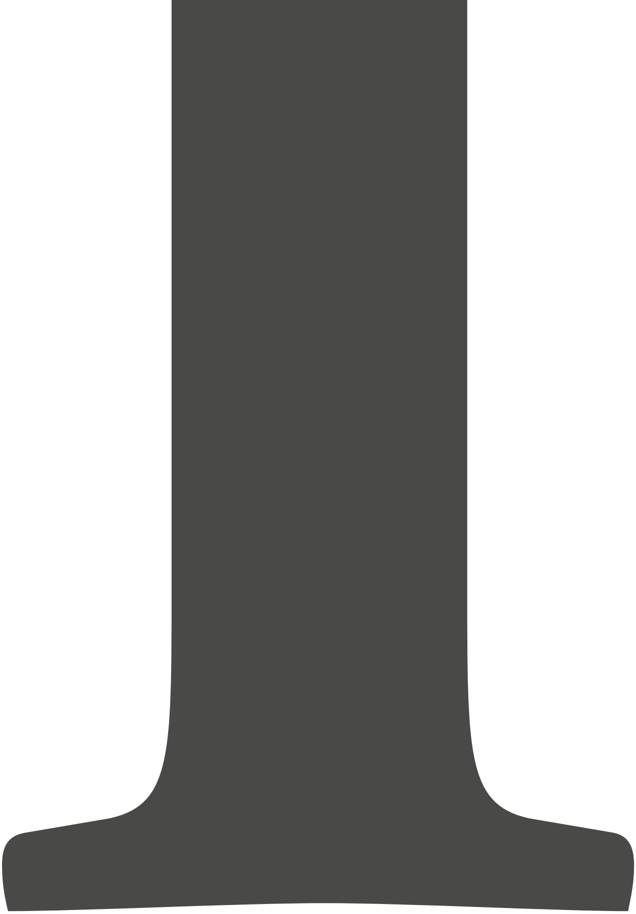




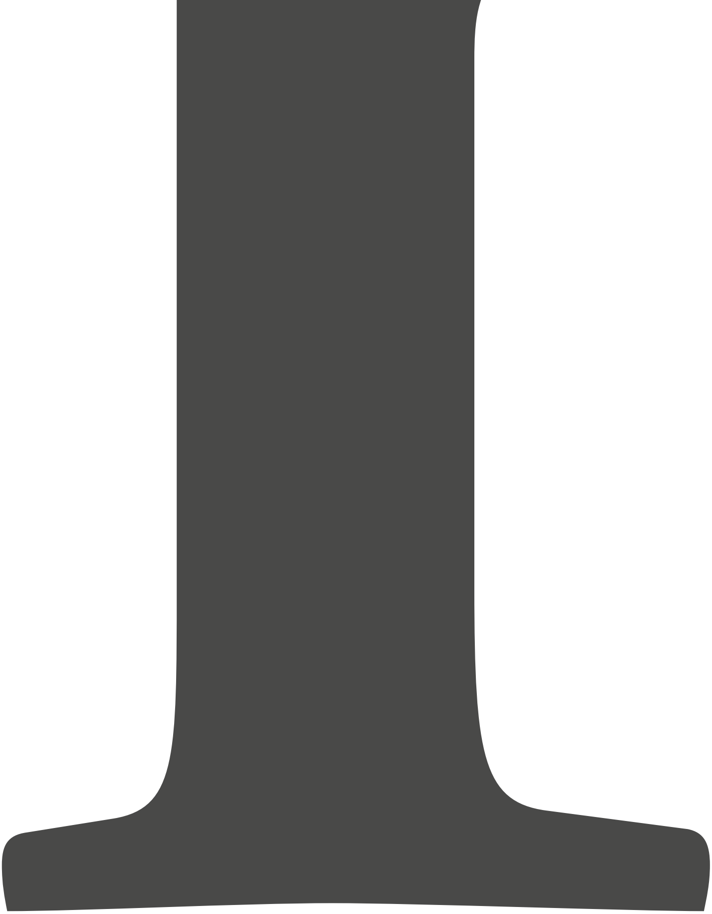


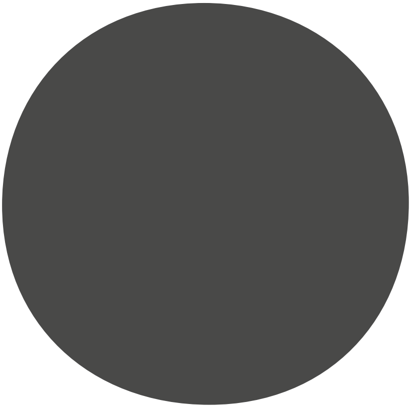




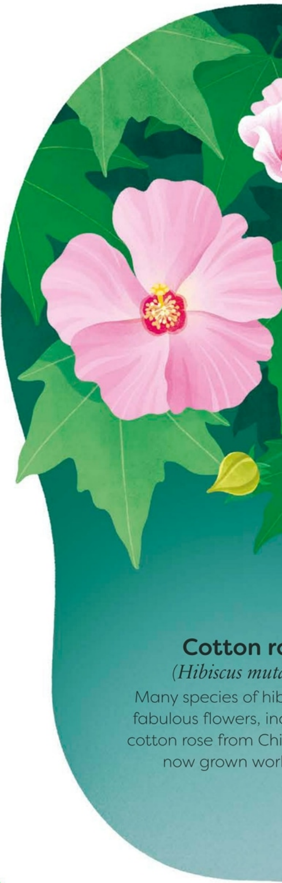


V





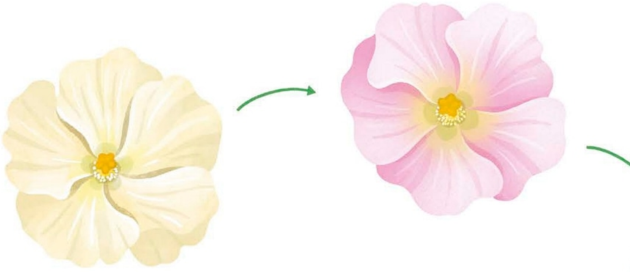
Hibiscus

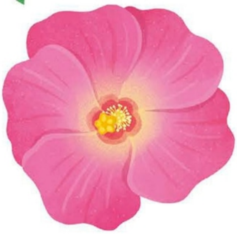


Cotton ro

(*Hibiscus muta*

Many species of hib
fabulous flowers, inc
cotton rose from Chi
now grown wor





Color change

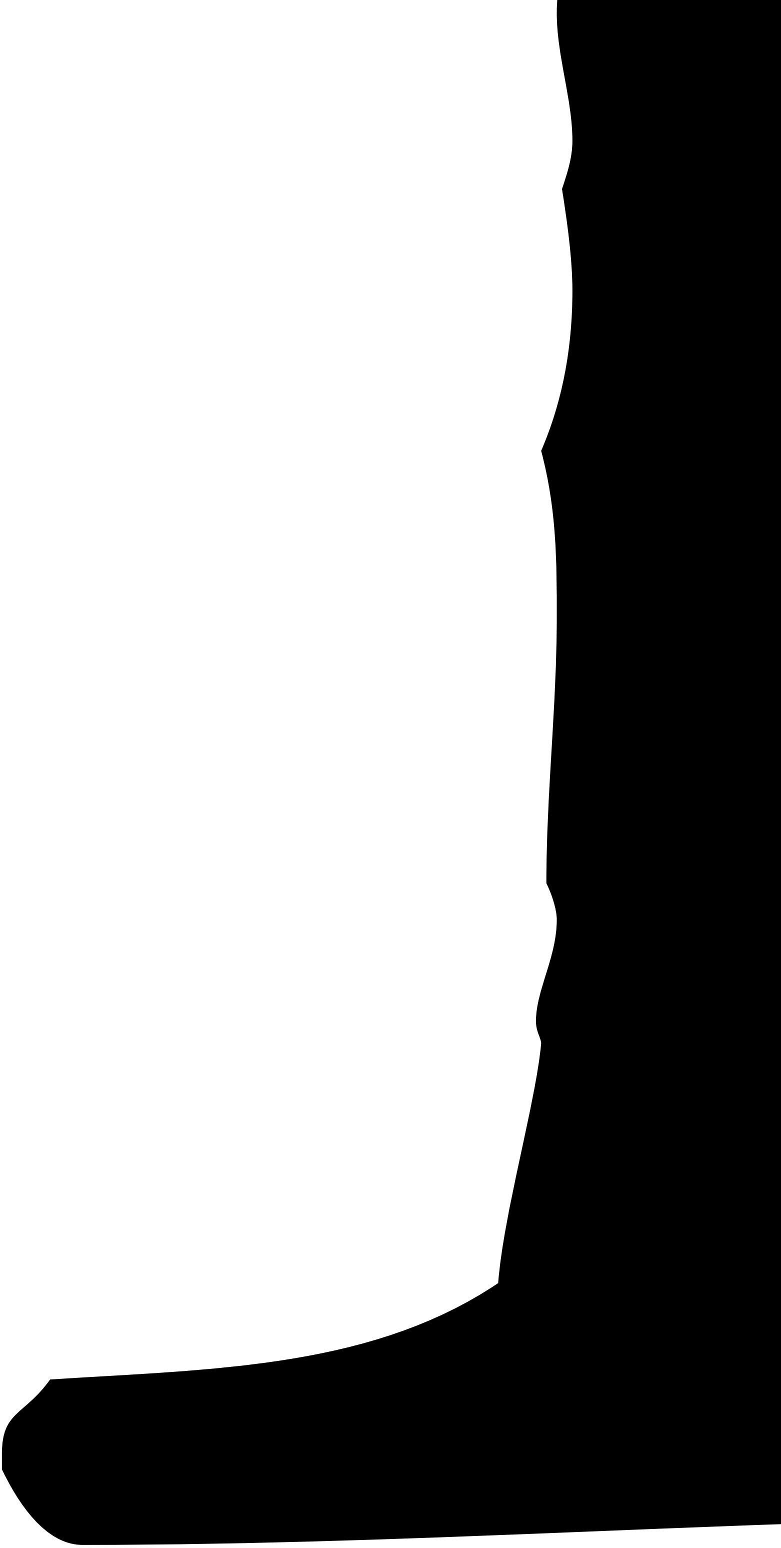
In the cool of morning, the cotton rose has white flowers. By the middle of the day, its flowers blush pink in the warmth of the Sun. In the afternoon, as the temperature continues to rise, the flowers turn a deeper shade of pink. The pink flowers soon fall off the plant.

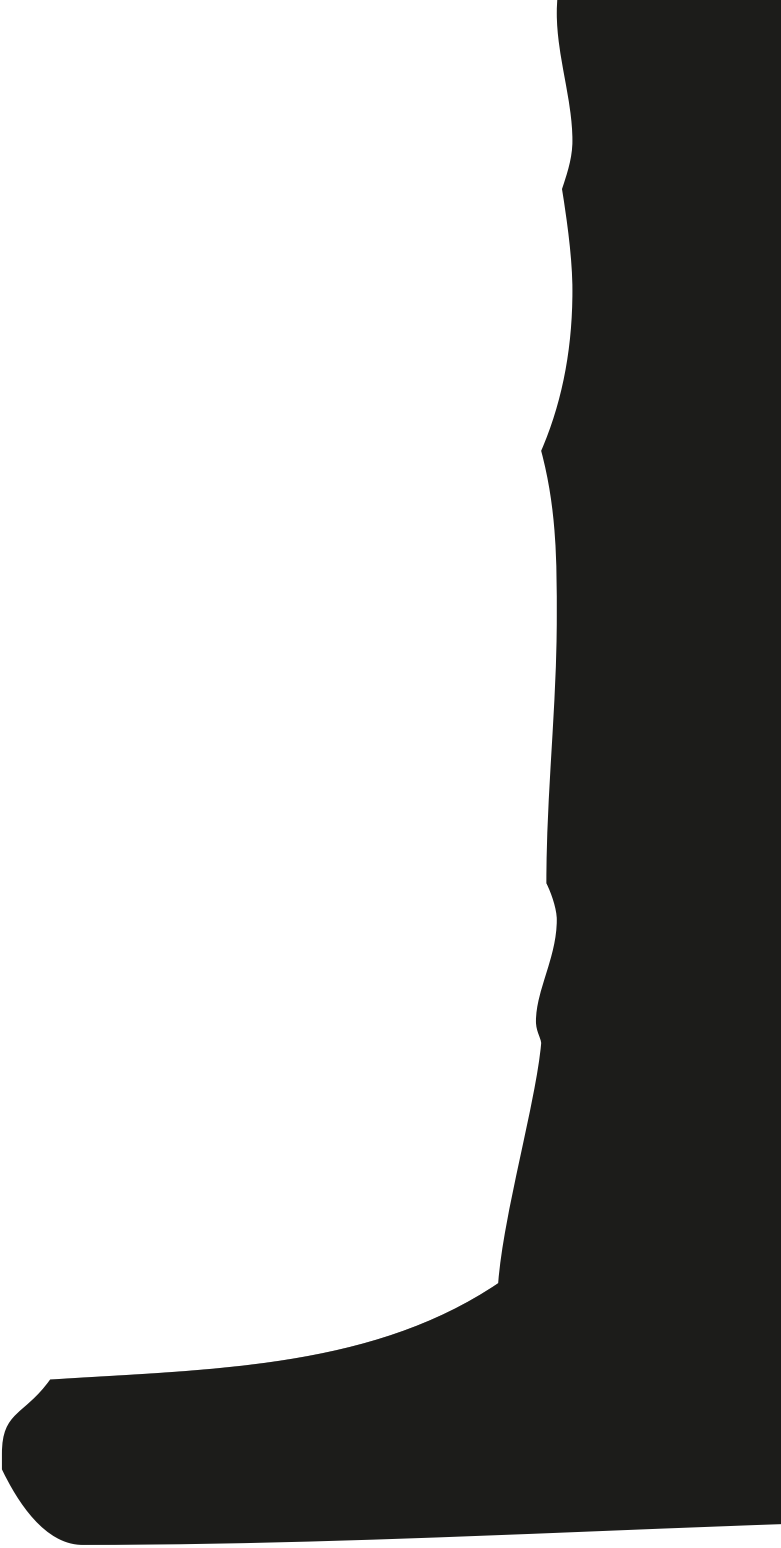
12

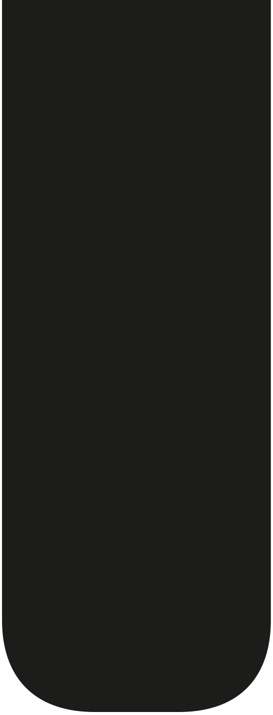
[redacted]

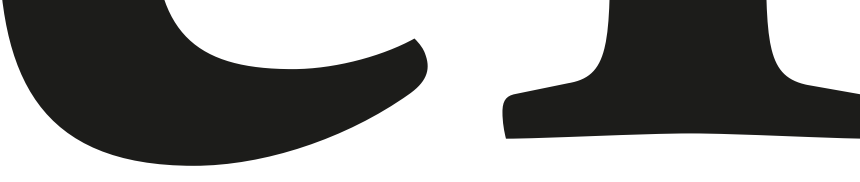
[redacted]

U









l

h

fl

th

ri

T

([illegible]

M

f

C

n

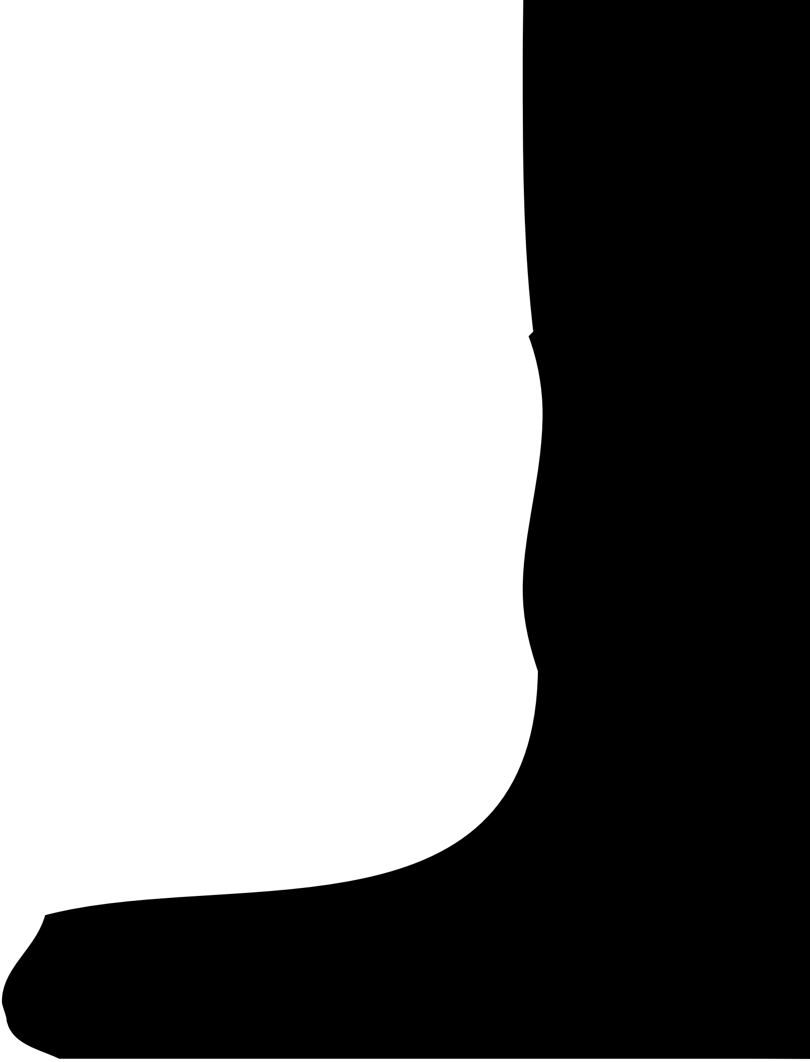
M

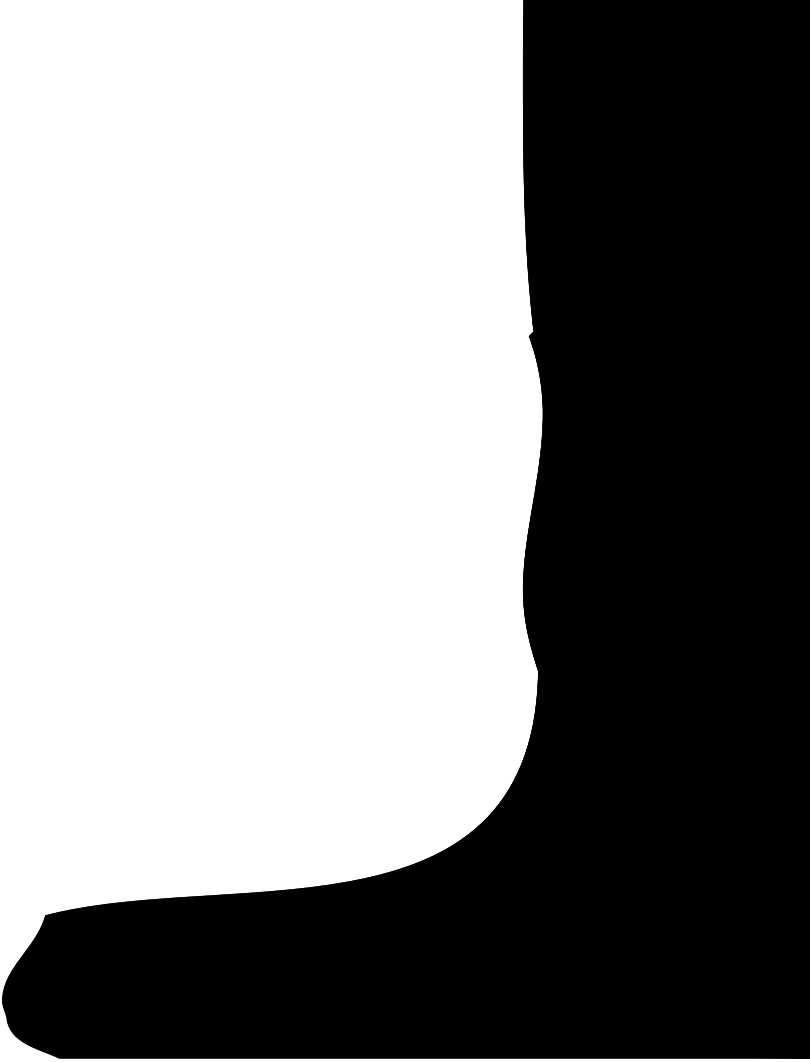
A

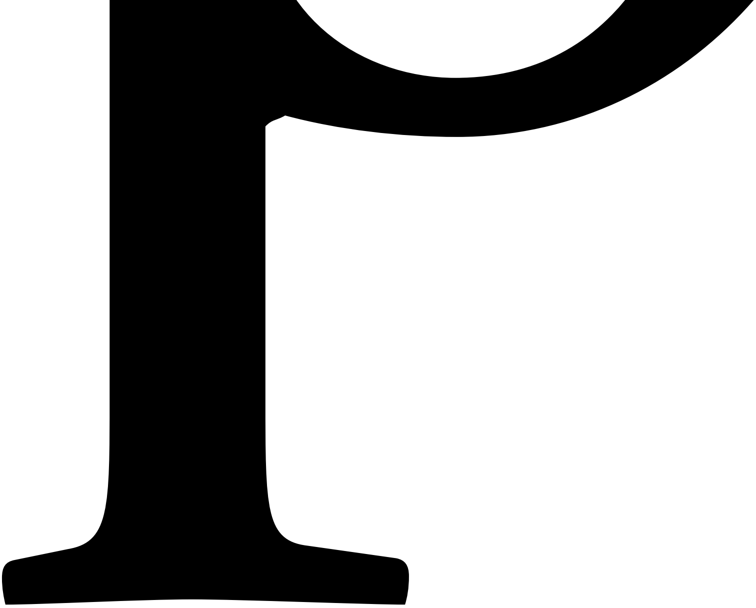
E

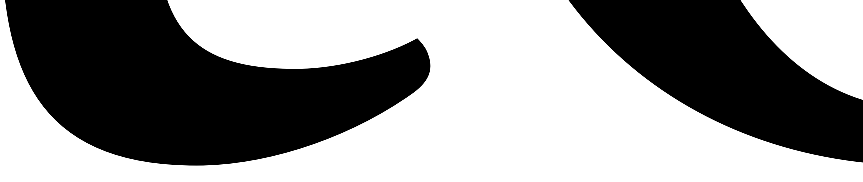
Blue bloom

The Himalayan blue poppy matches the color of the sky on a fine summer day. True blue flowers like this are very rare in nature, because blue pigment is difficult for plants to make. Most "blue" flowers actually reflect light to create the illusion of the color. This also saves the plant energy because colorful pigments used to attract pollinators cost energy to make.

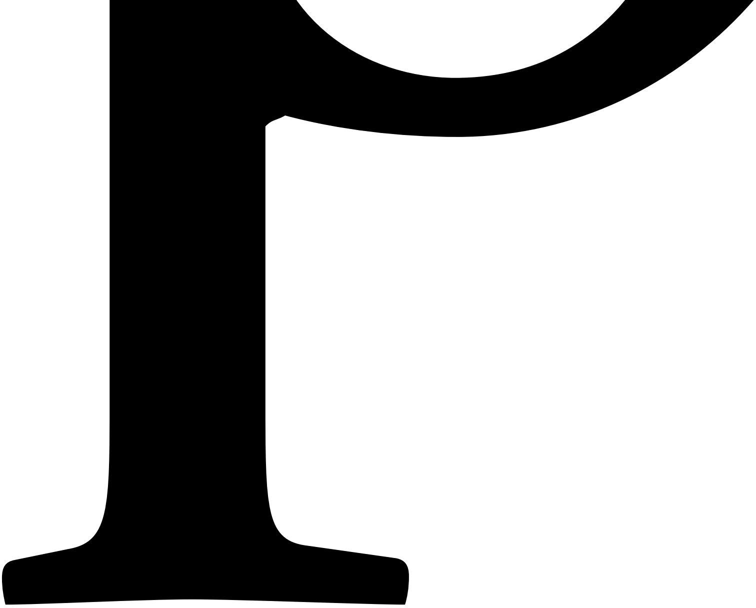




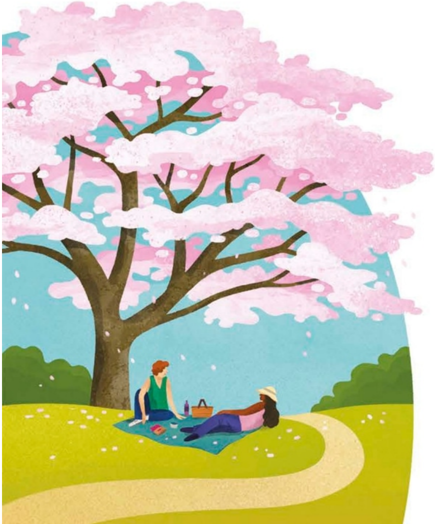




p



Japanese cherry



Japanese cherry

(Prunus serrulata)

There are many types of cherry trees but this is one of the most famous. It grows all over Japan, and is also found in China and other parts of eastern Asia.

Blossom forecasts

It is warmer in the south of Japan, so cherry trees flower there first, followed by trees farther north. As spring moves north, a great wave of blossom sweeps through the country. Blossom forecasts predict when it will arrive in each area.

lt

S

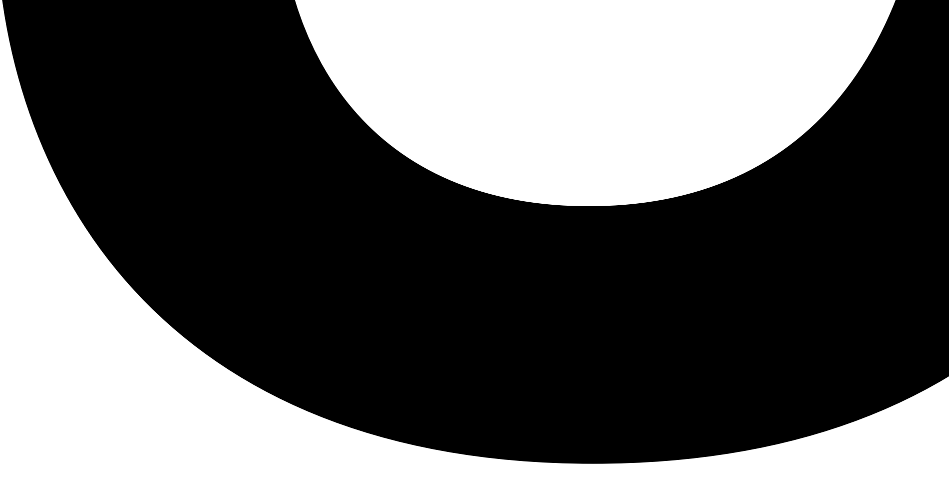
fo

sp

O

C

w



T

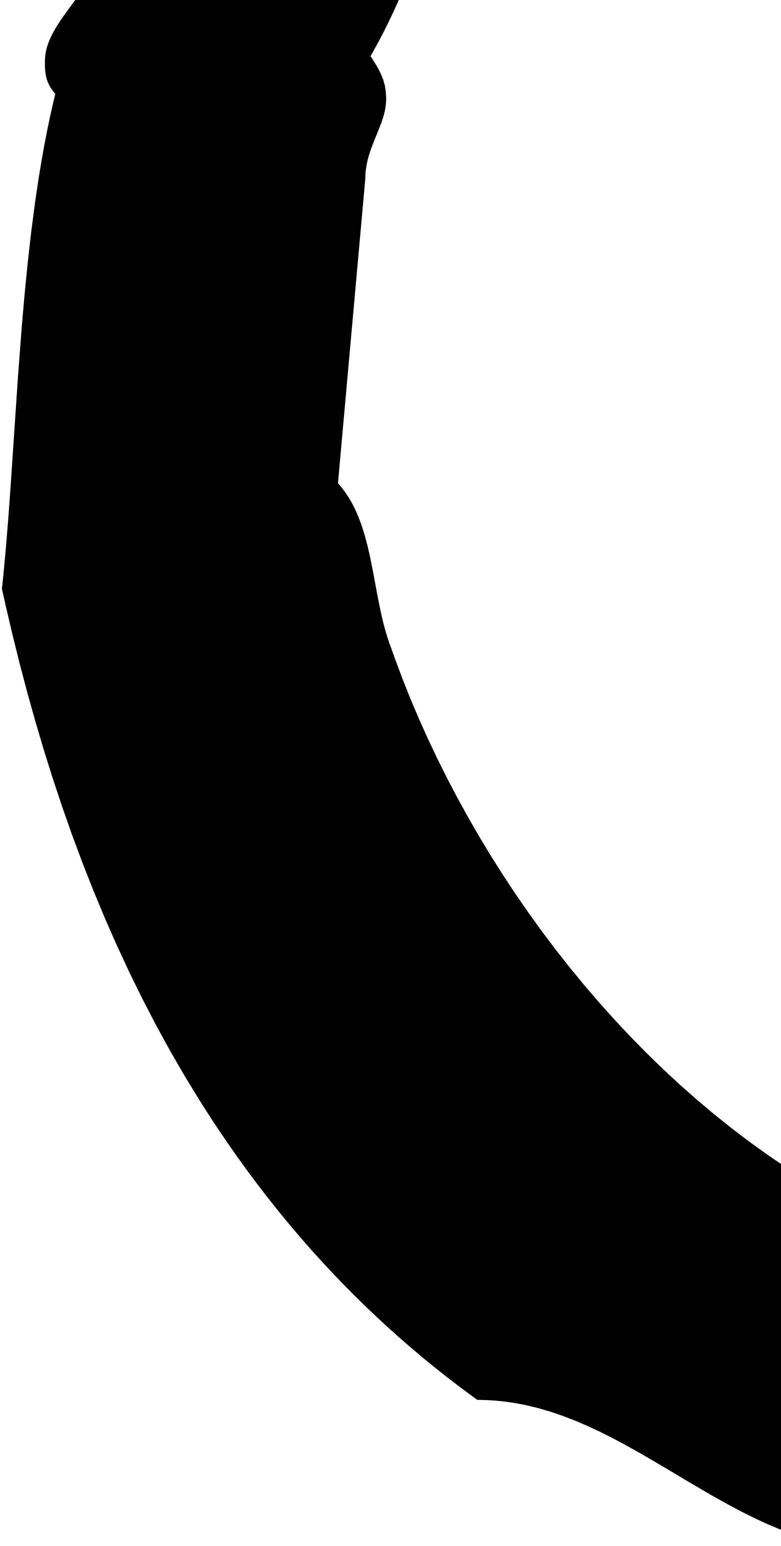
tr

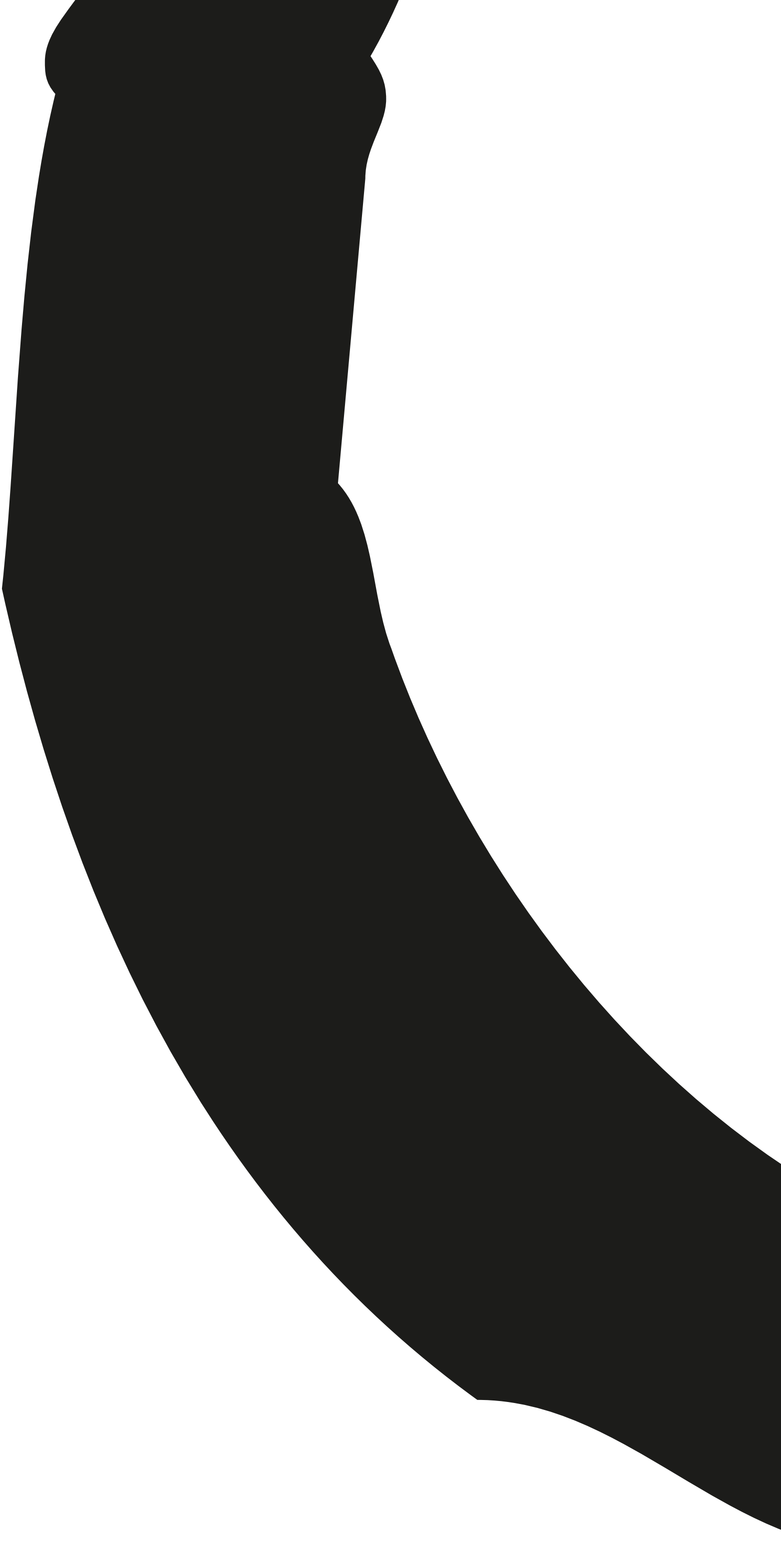
f

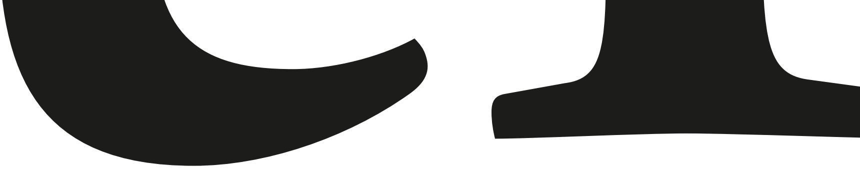
J

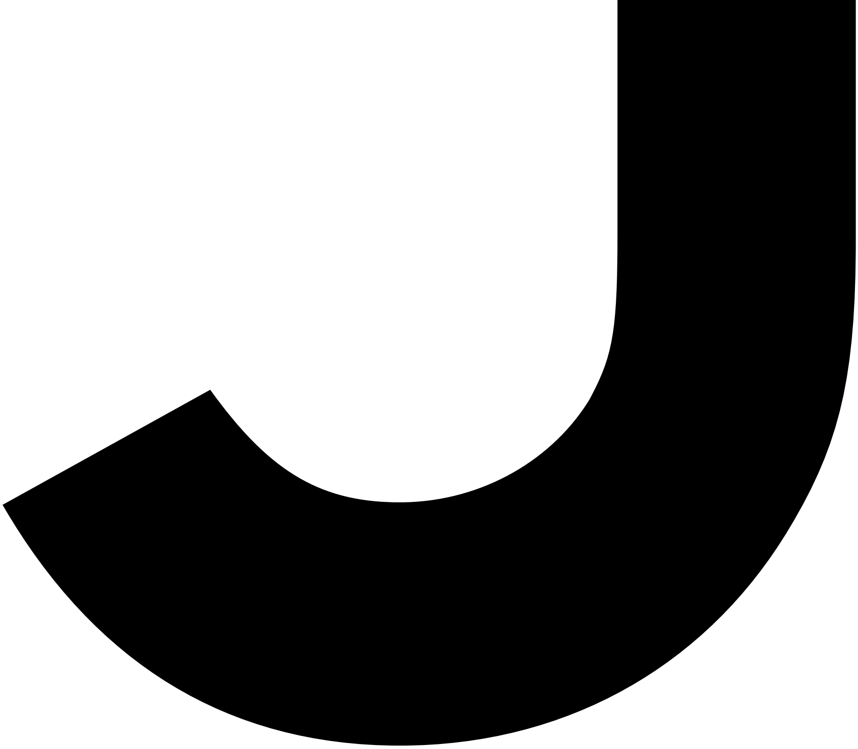
C

e









[redacted]

L

[redacted]

E

C

d

S

fl

th

n

T

p

a

L

tr

b

h

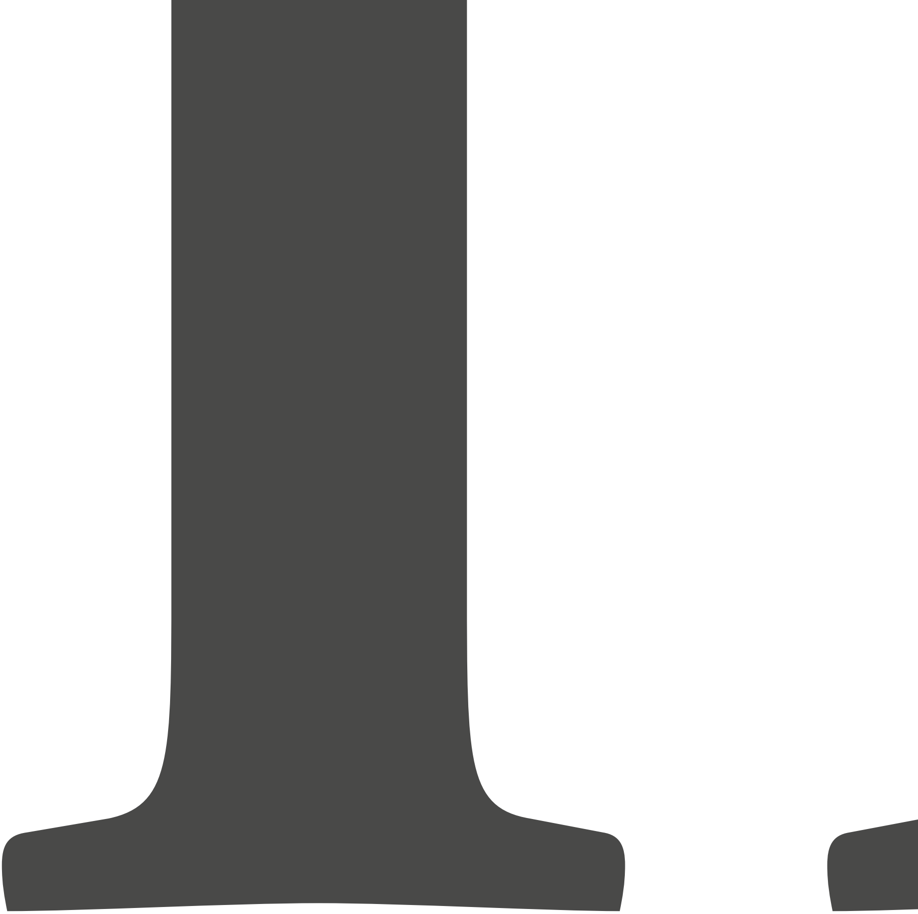
e

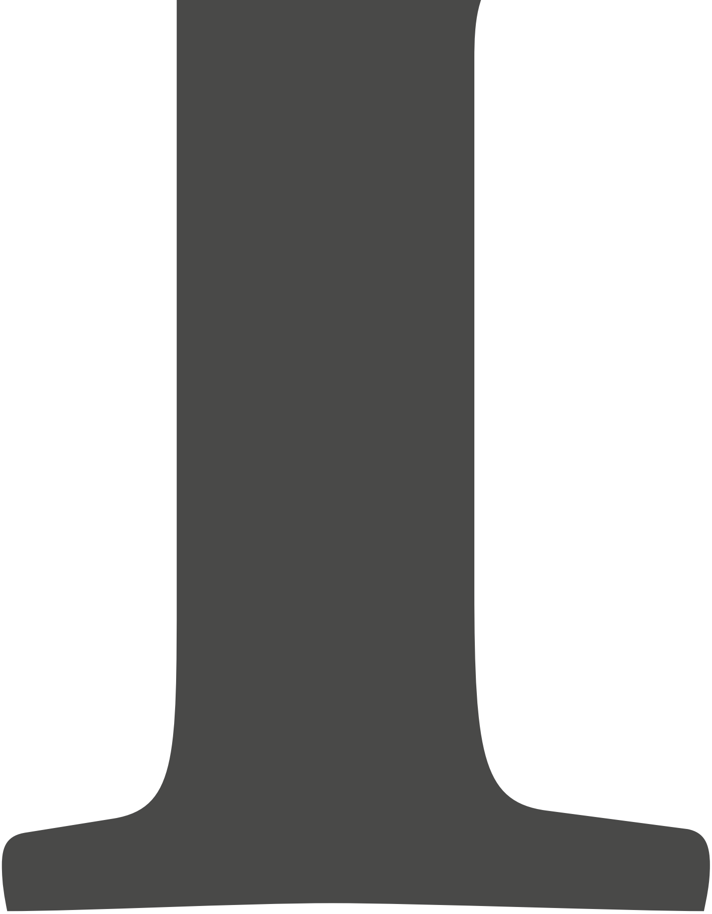
th

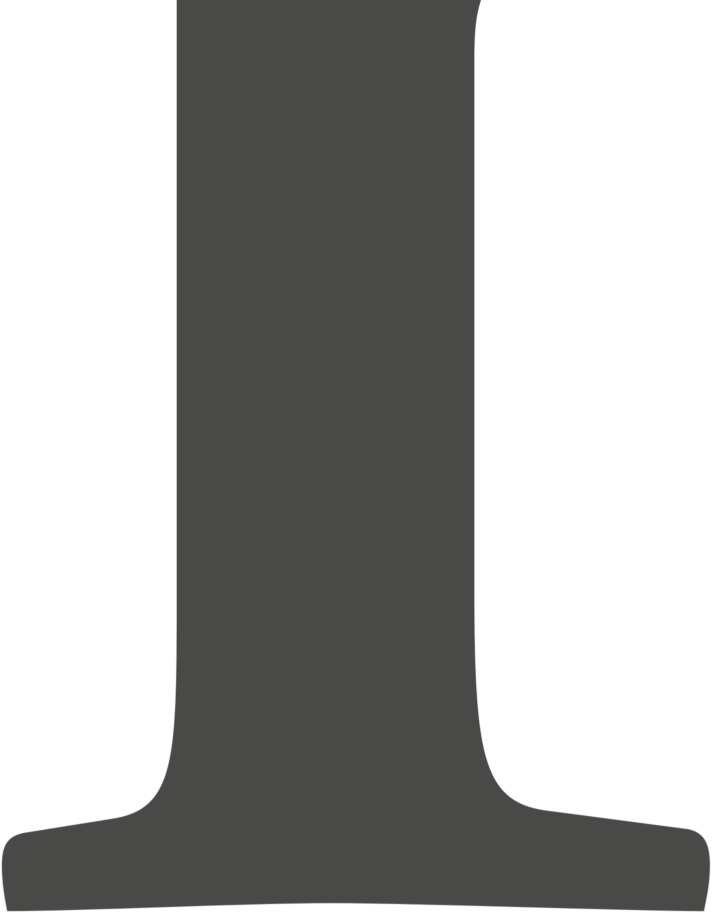
B

sp

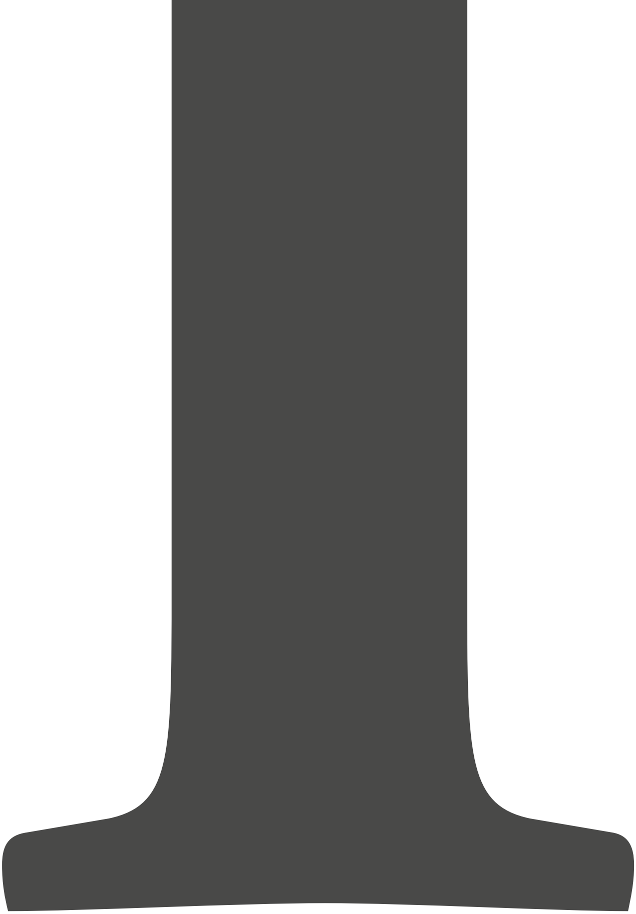
d



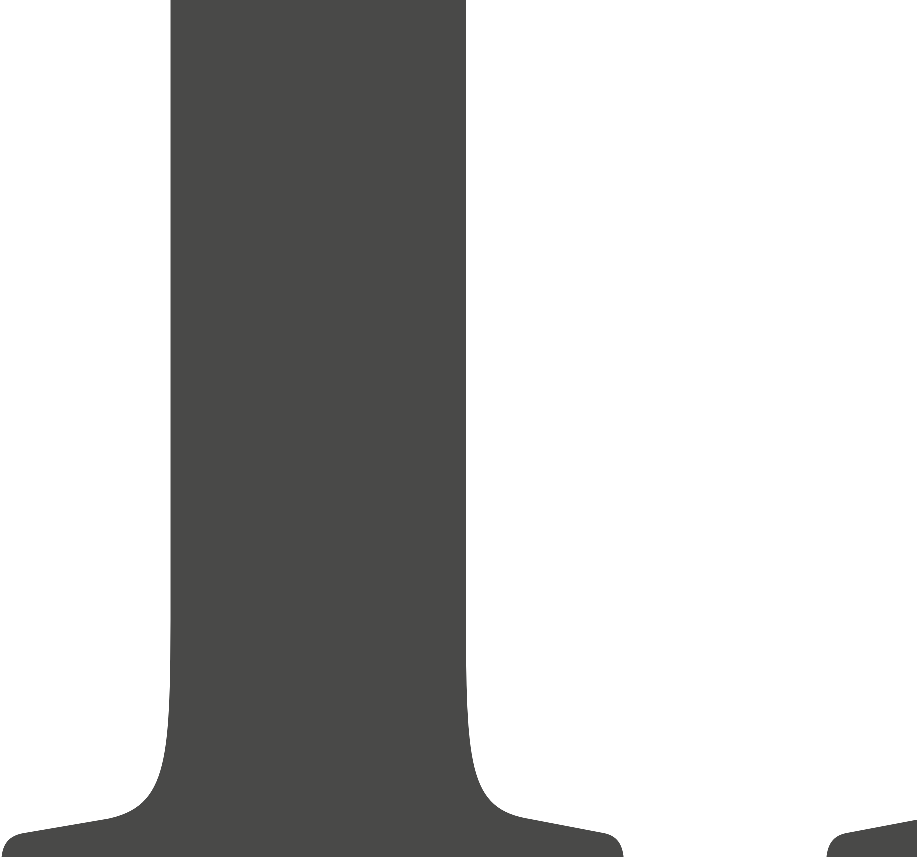


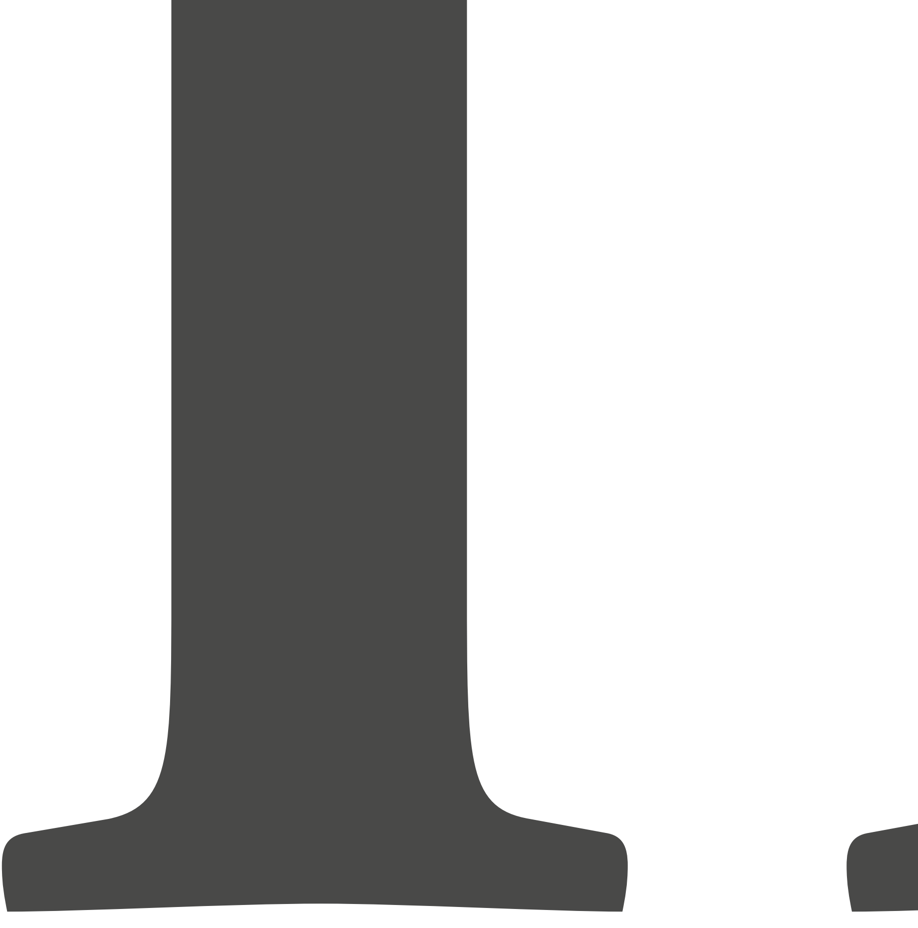


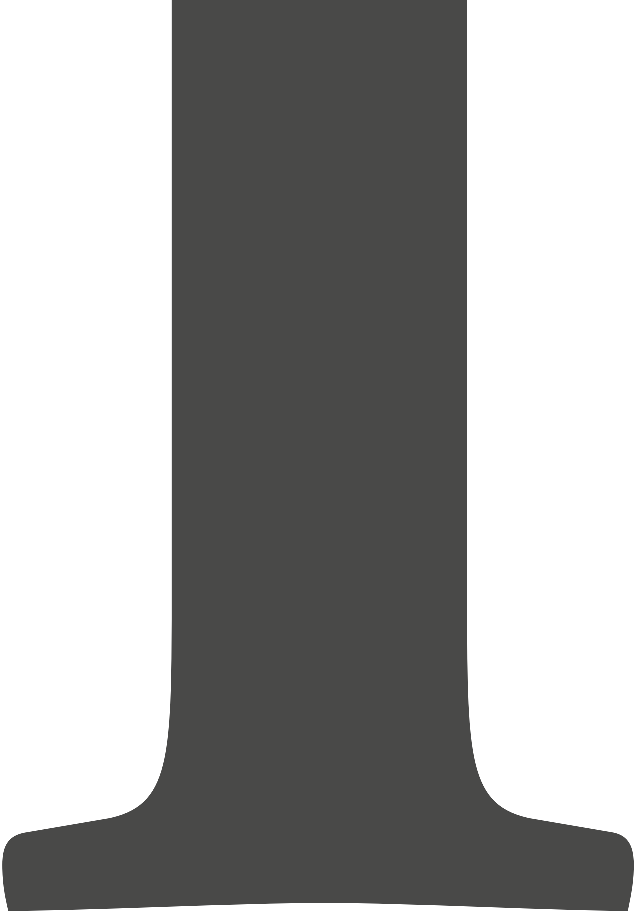
y



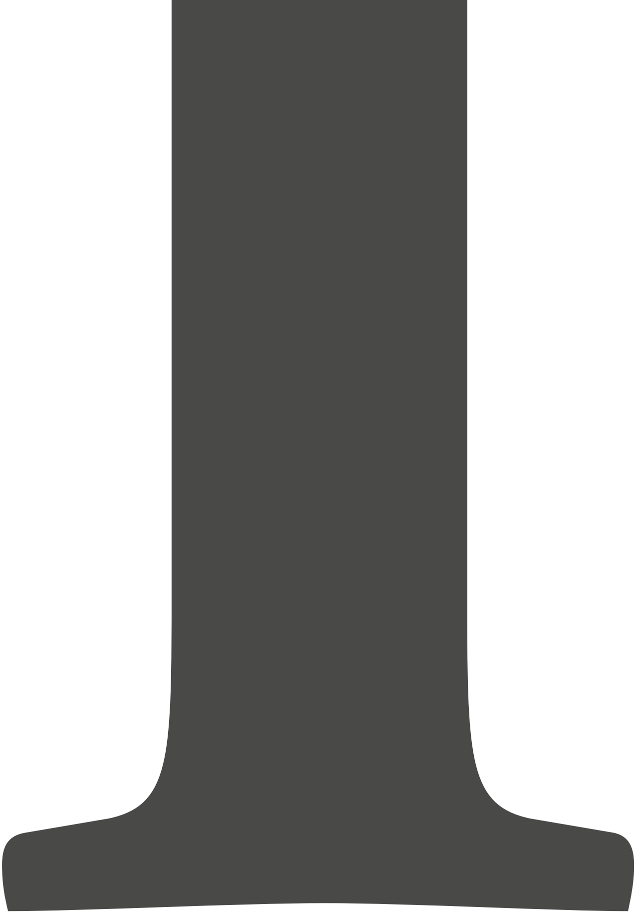
S



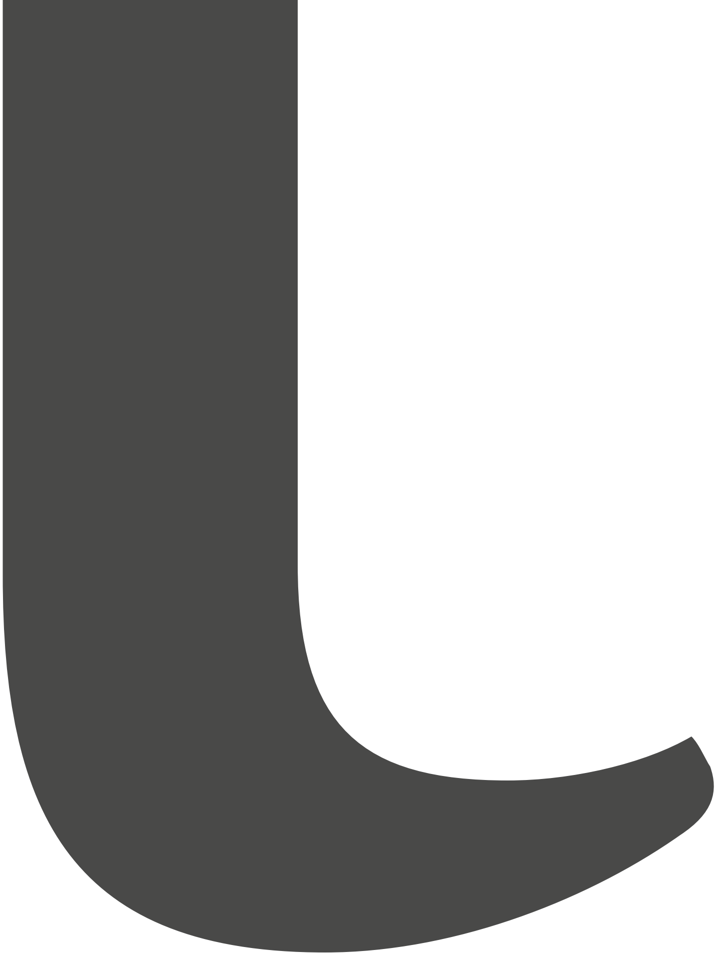




y

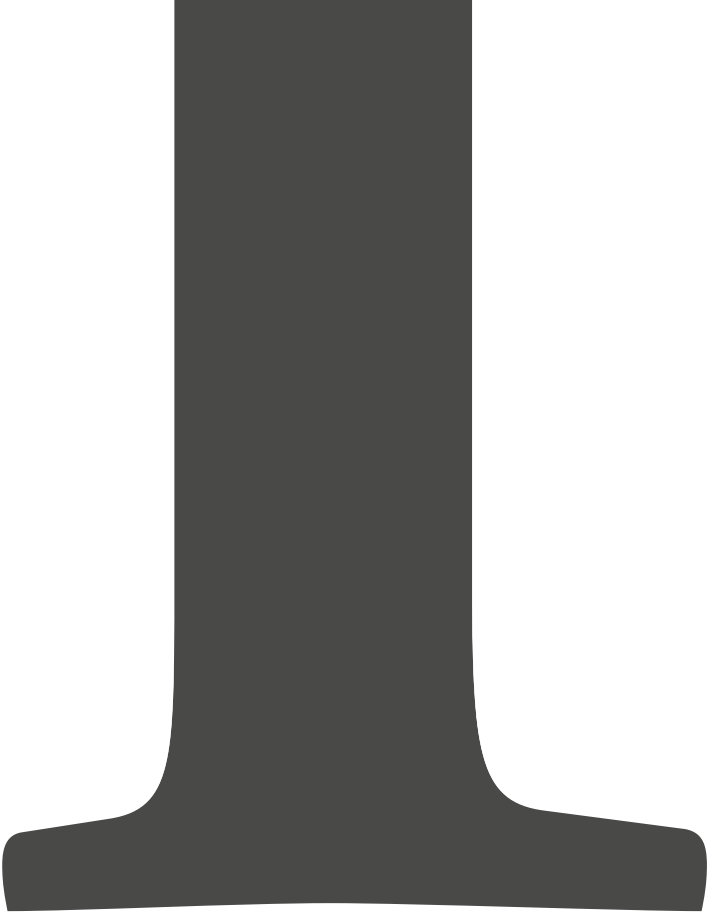


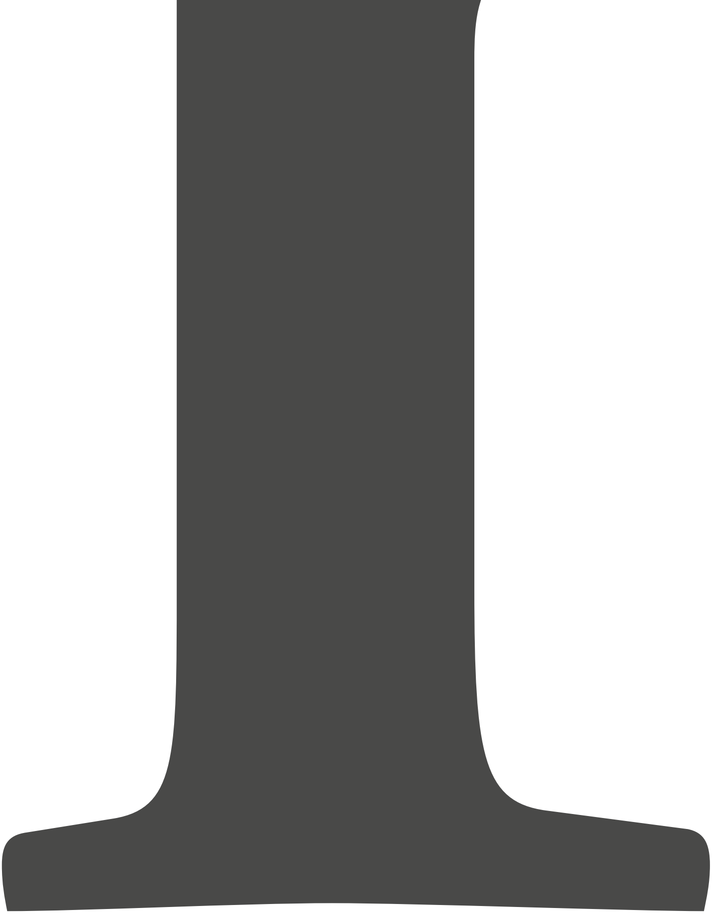
a

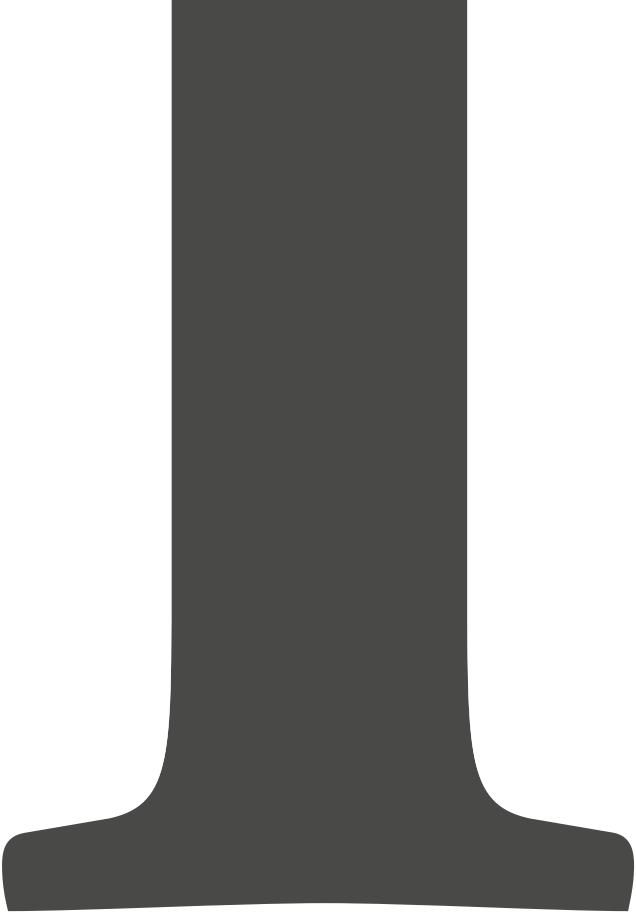


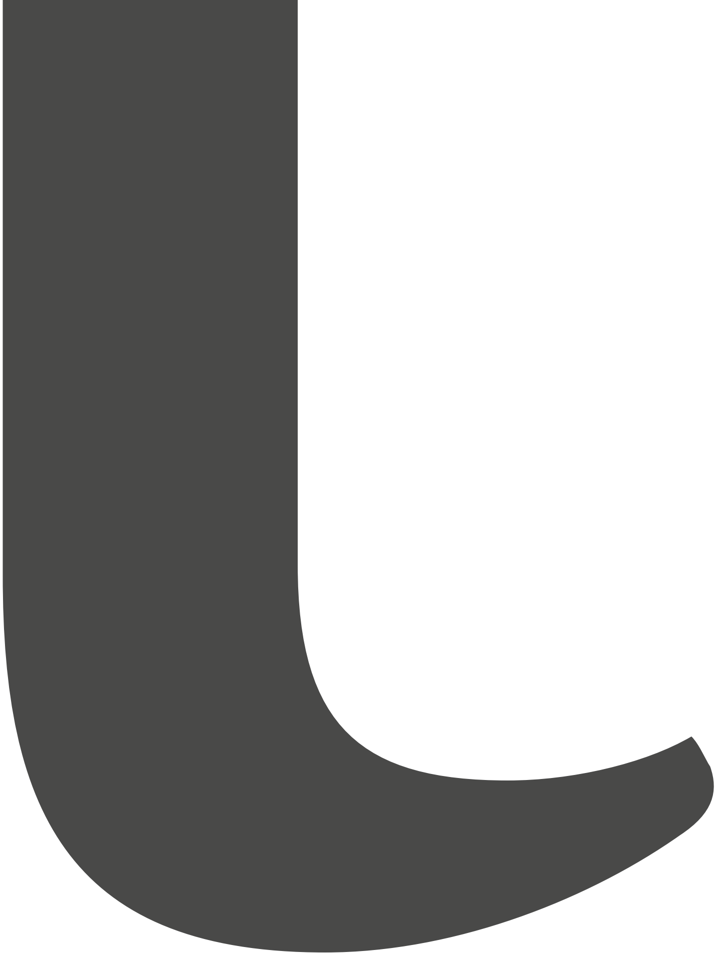
V

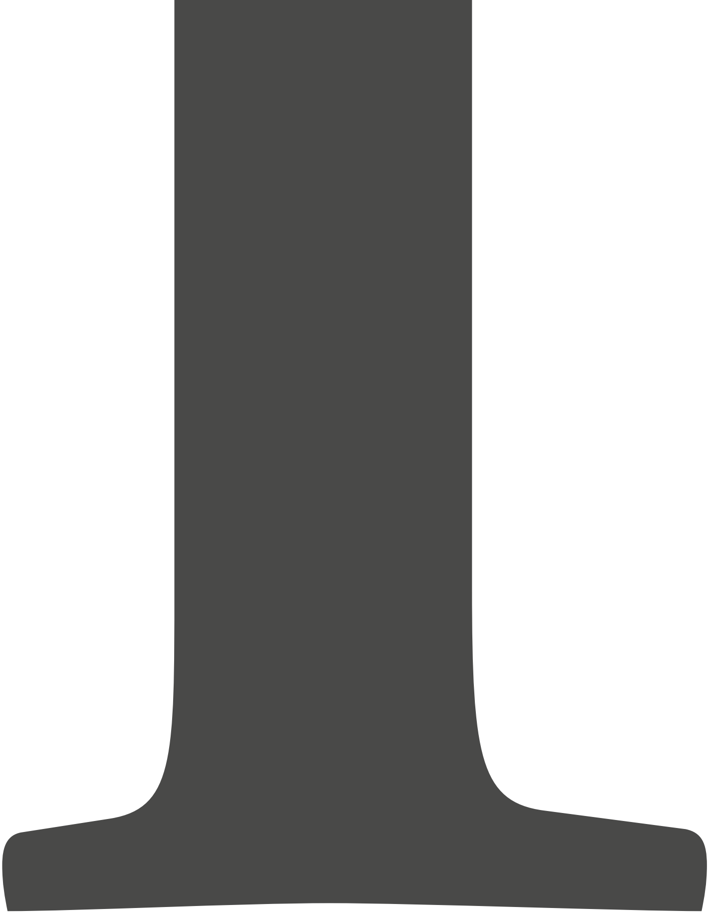
K

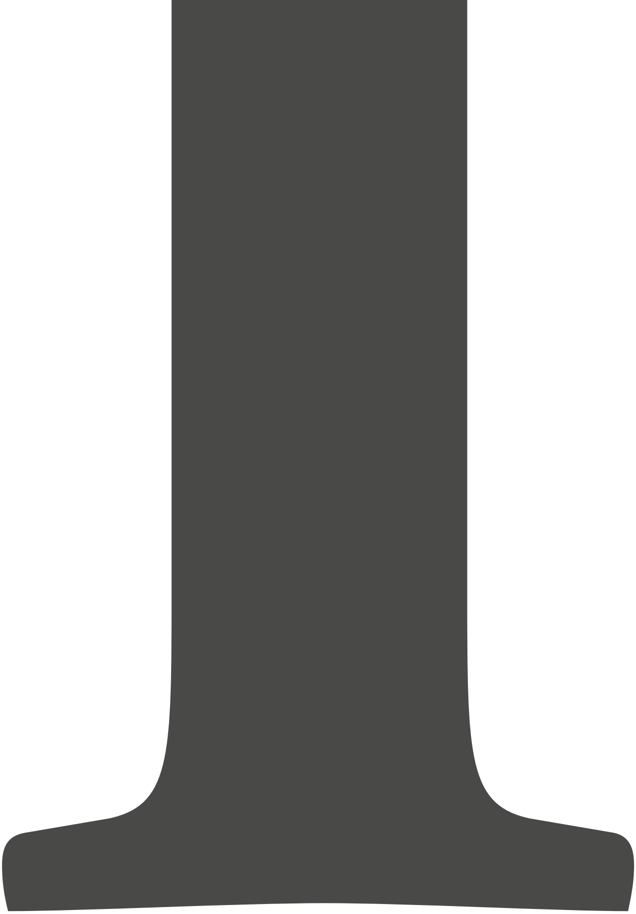


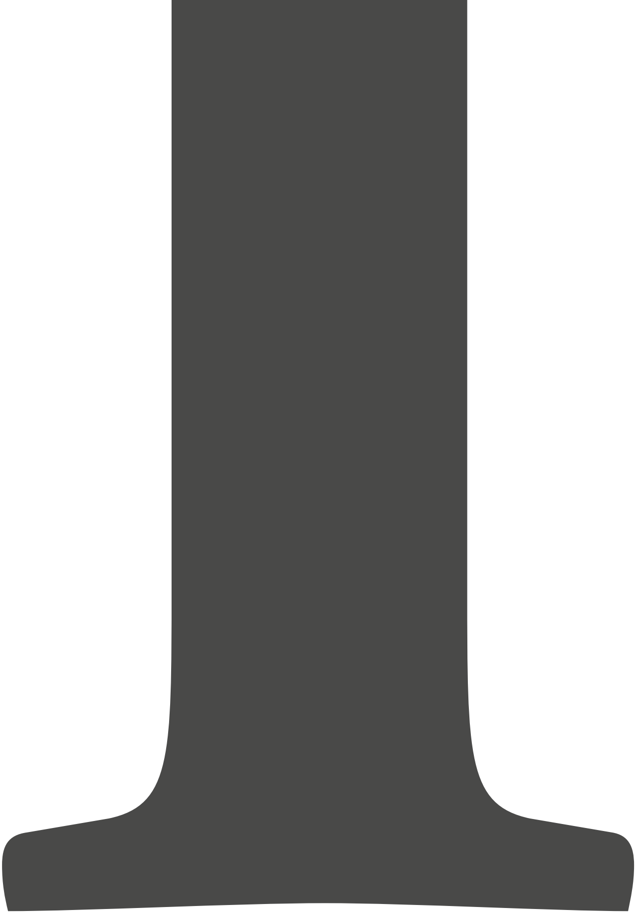


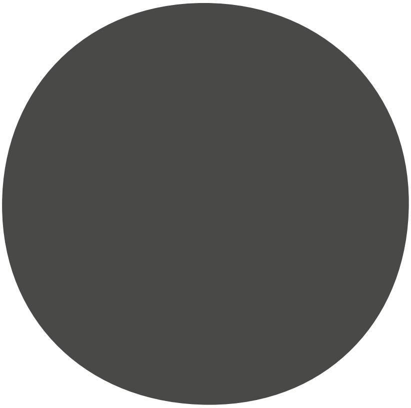


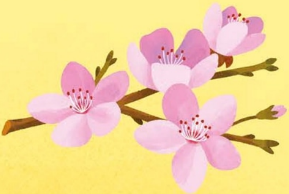


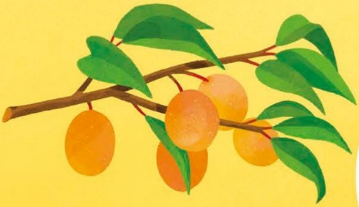












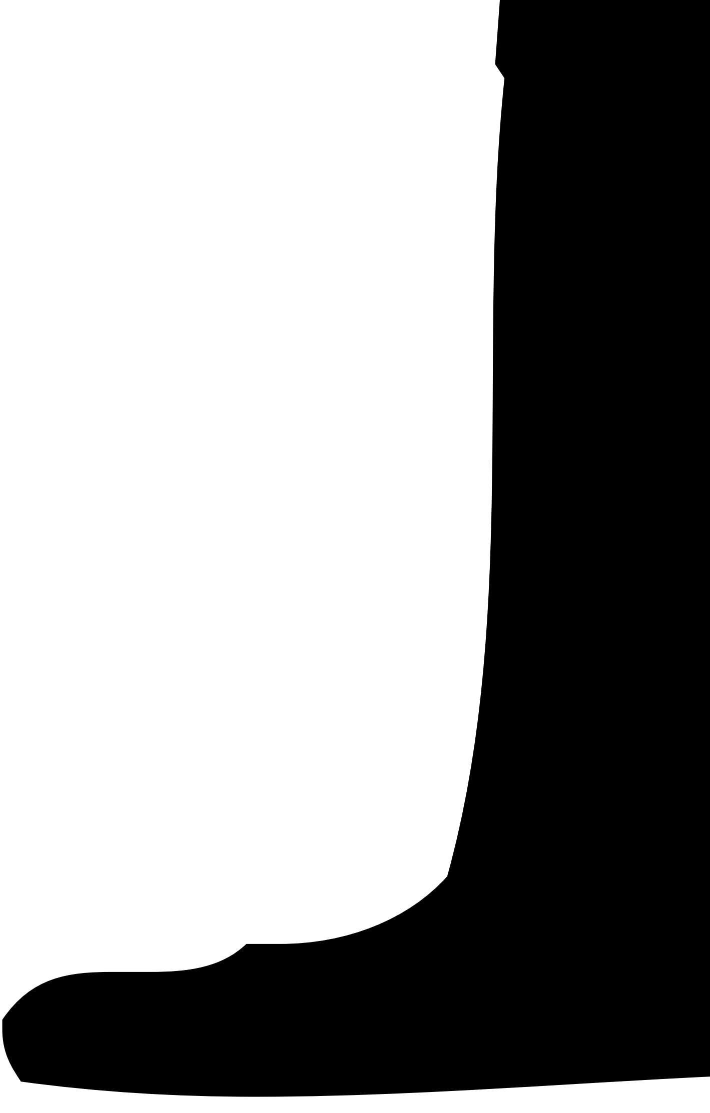
From blossom to fruit

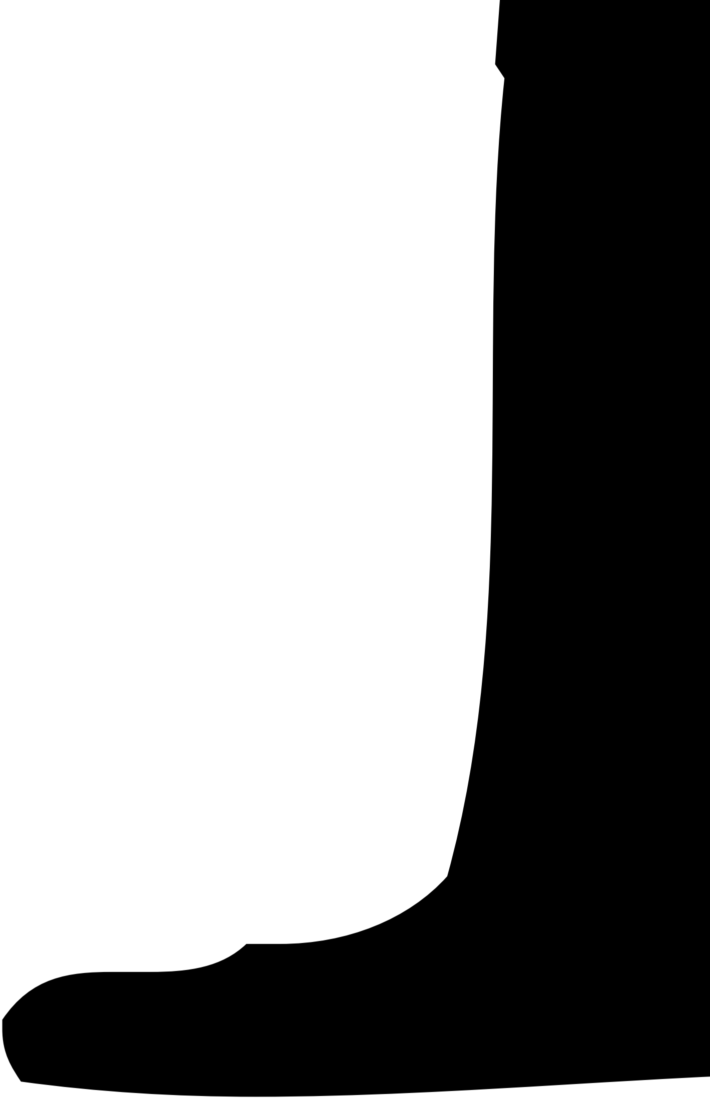
When blossoms are pollinated, in each individual flower a fruit will grow and ripen in the sun. Certain blossom trees provide some of our tastiest edible fruits, including apples, cherries, peaches, and plums.

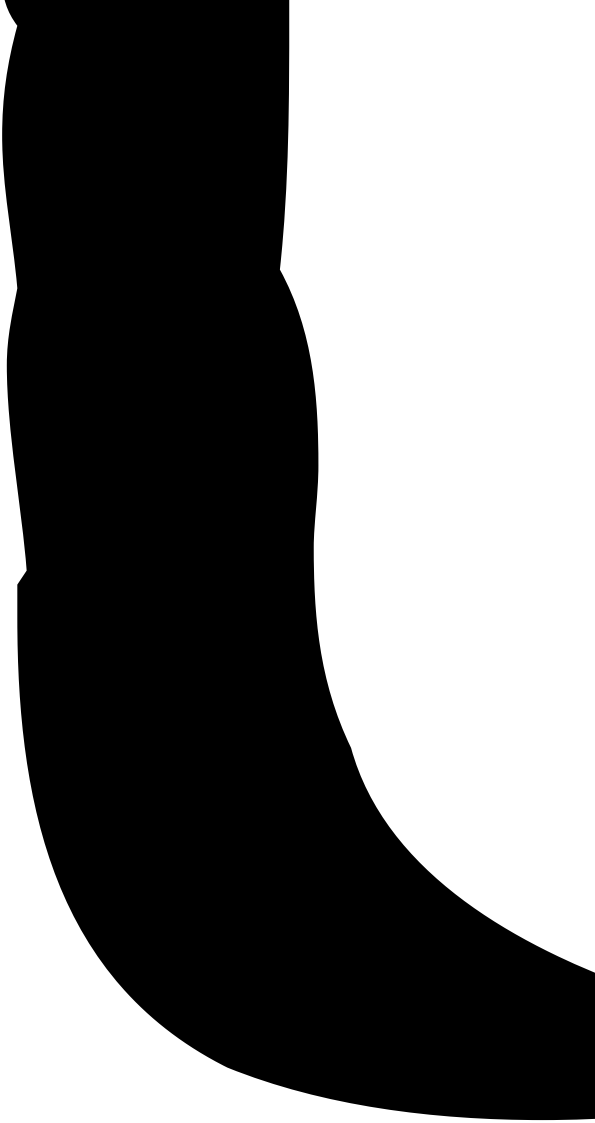
P

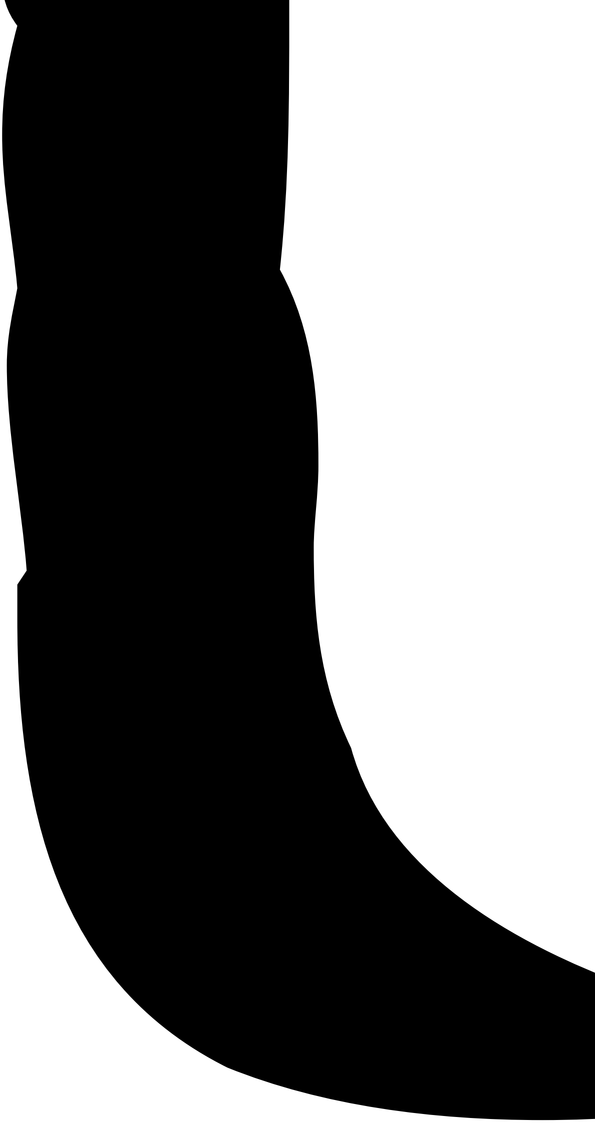
b

P

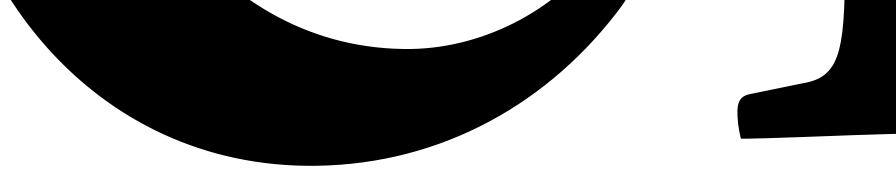








g



B

b

p

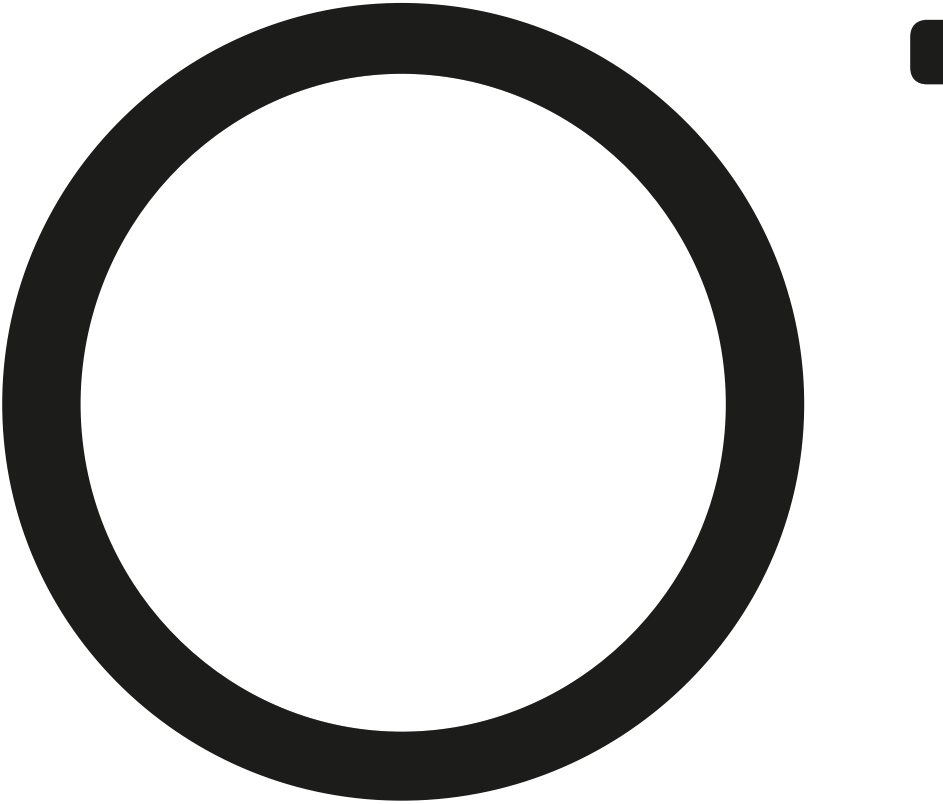
sp

T

b

fr

T



C

n

tr

W

C

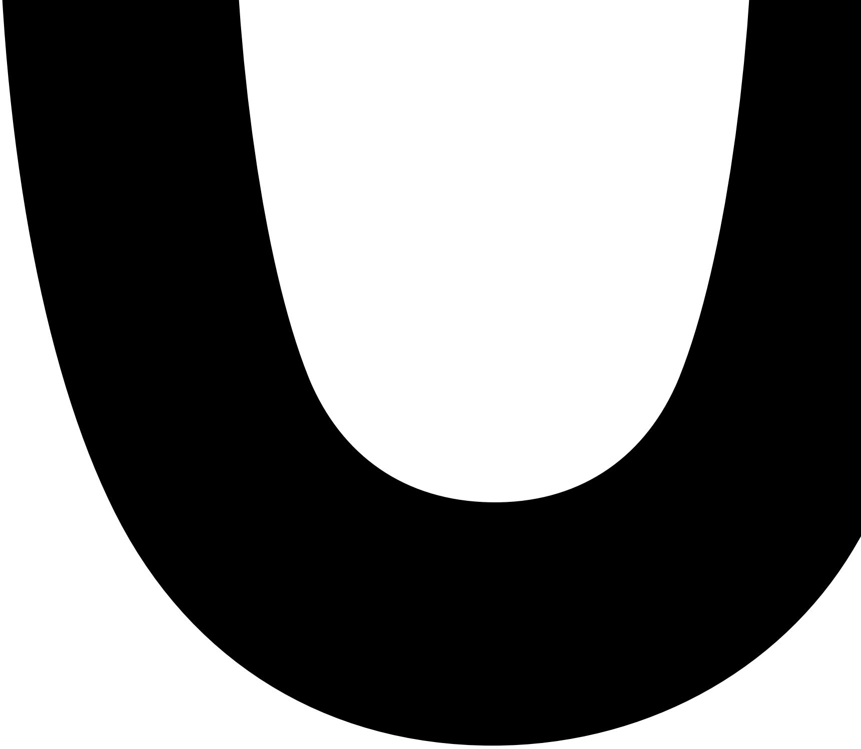
b

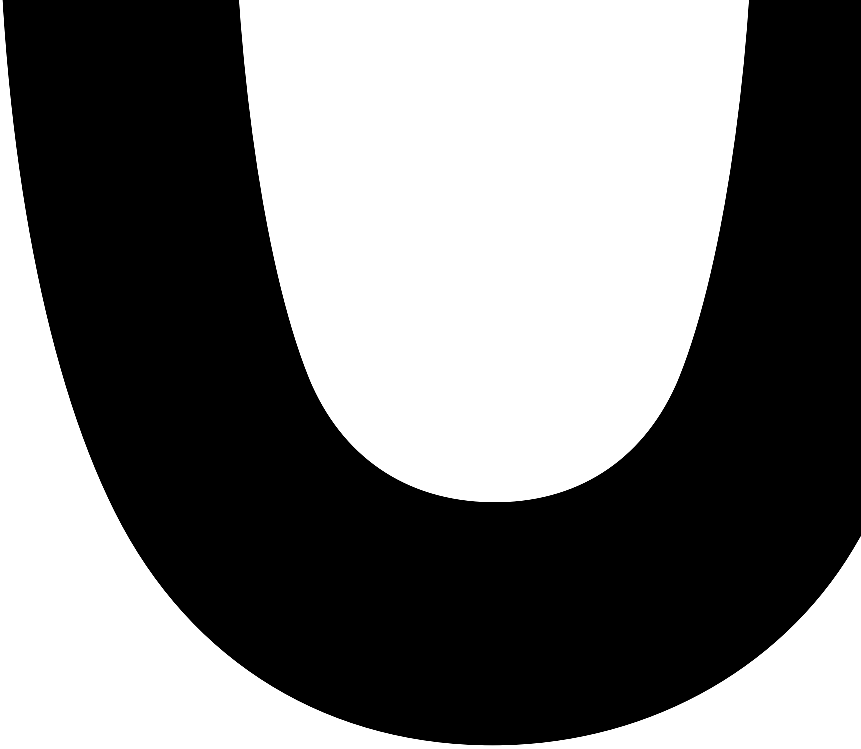
W

W

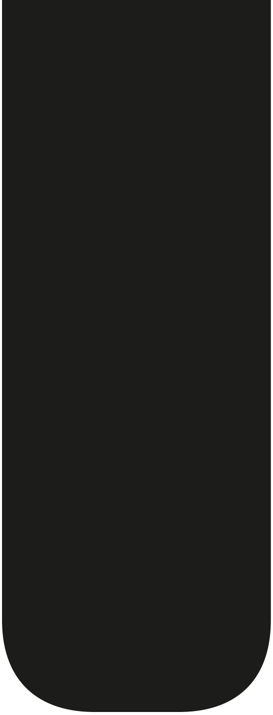
p

Blossom





IV



Y

g

st

tr

b

A

b

p

sp

b

In

m

th

th

ri

T

m

C

p

sp

T

E

m

in

sp

T

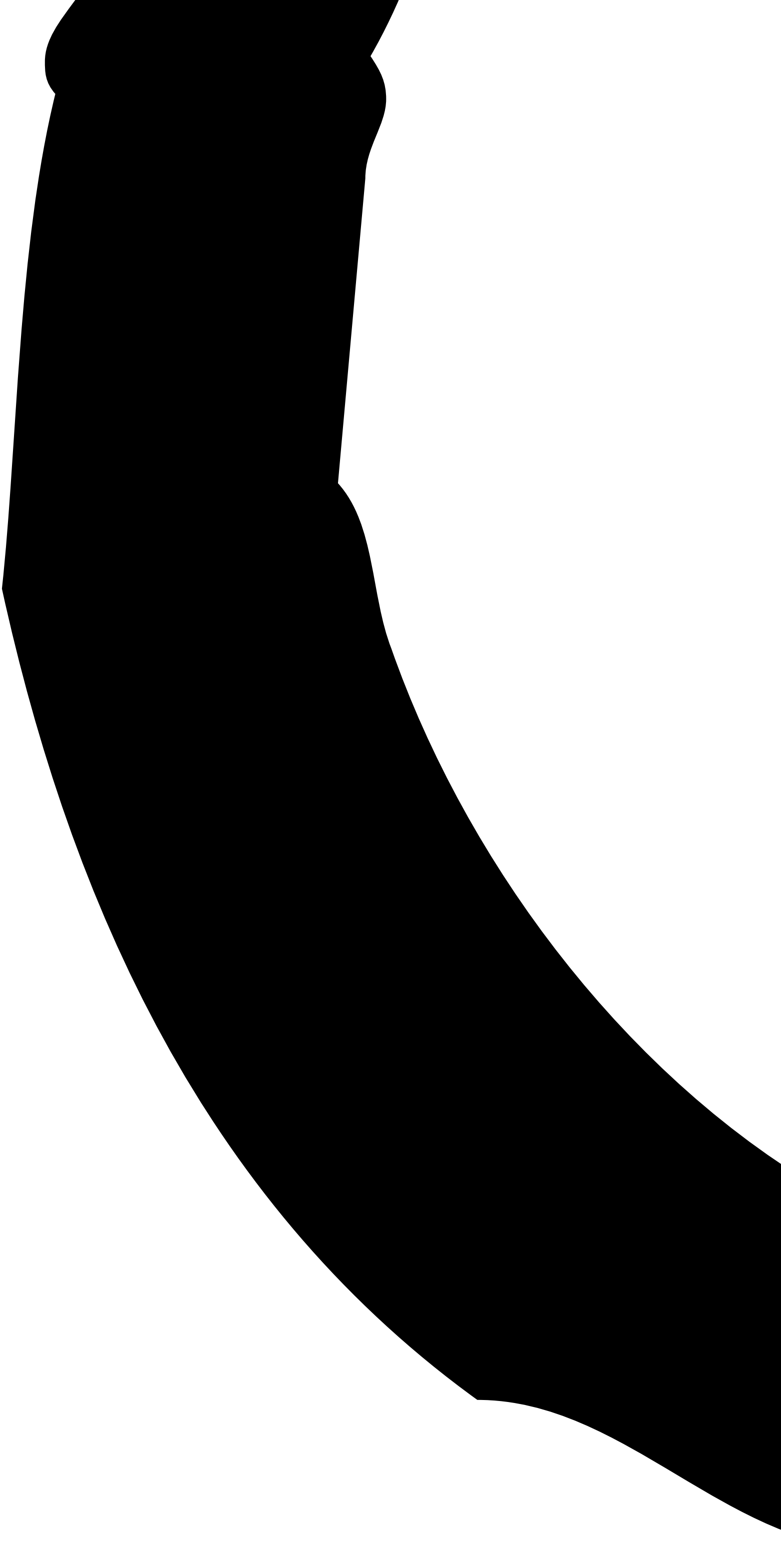
M

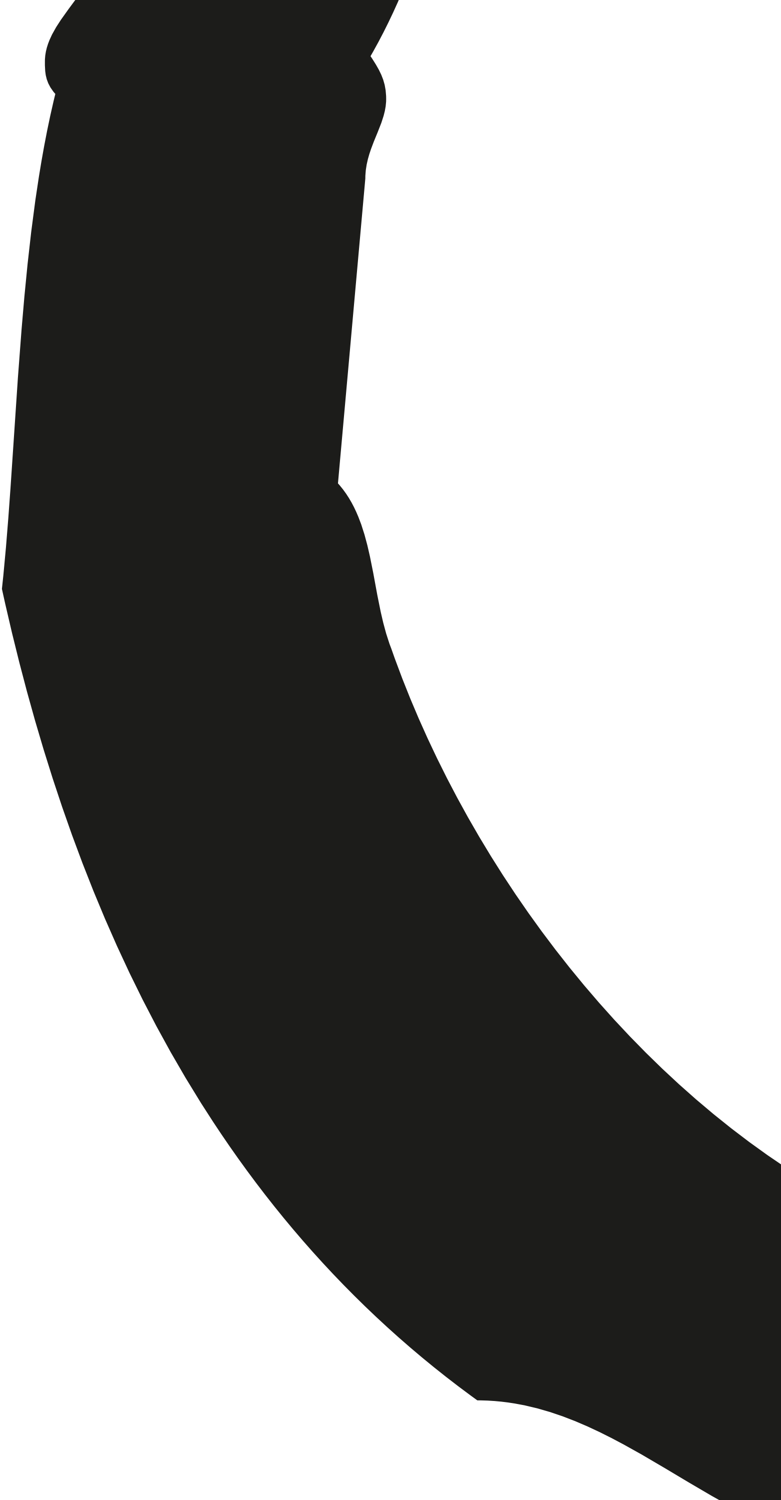
g

b

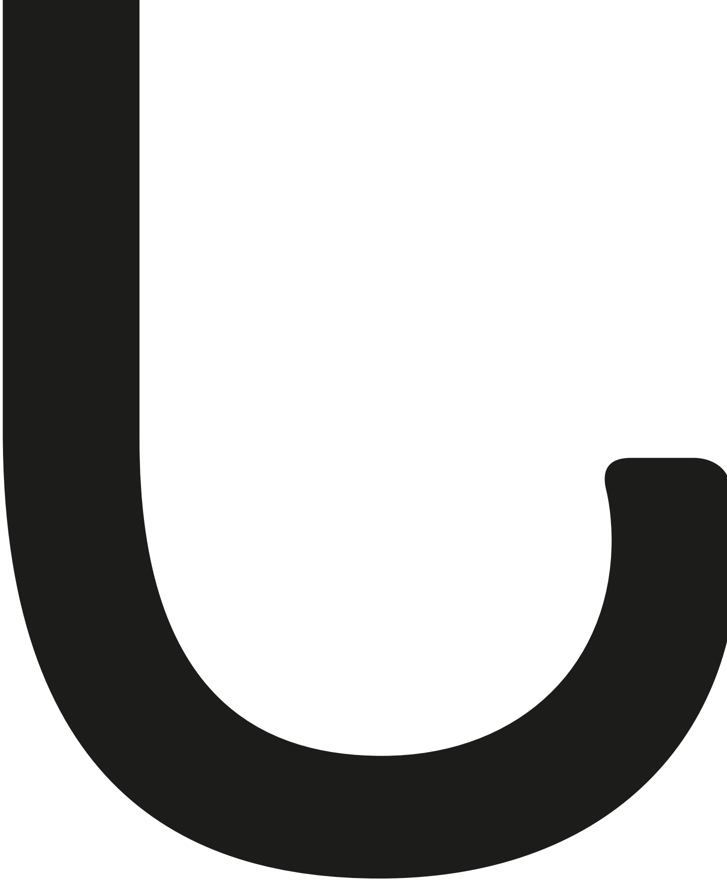
b

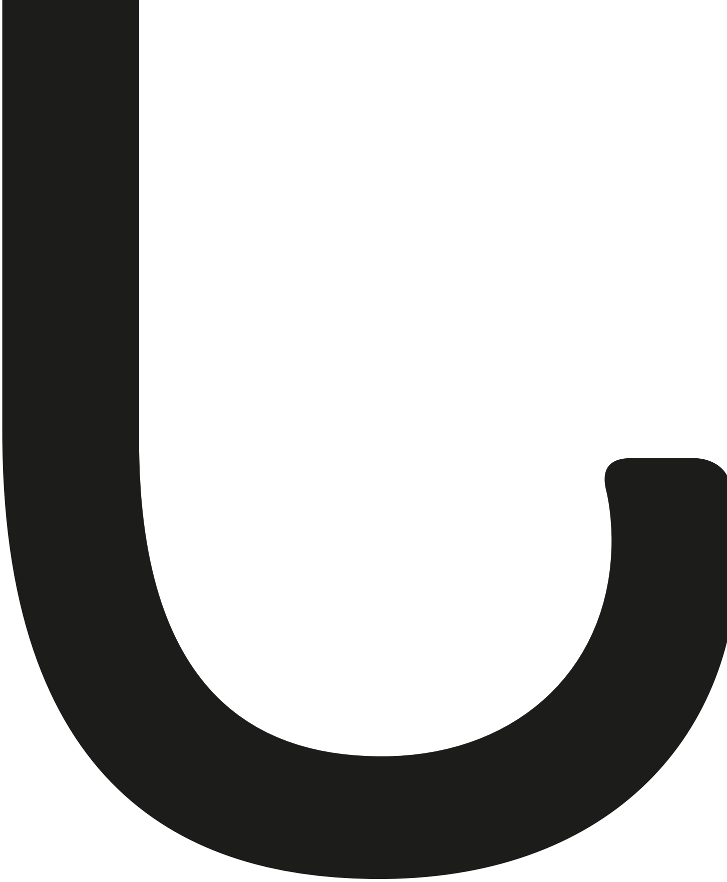
Fruits and cones

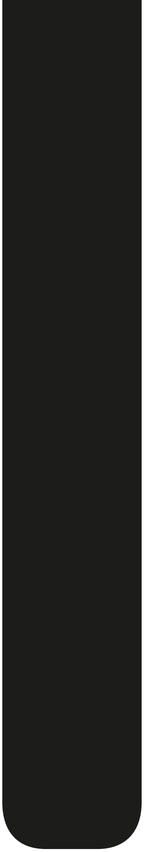


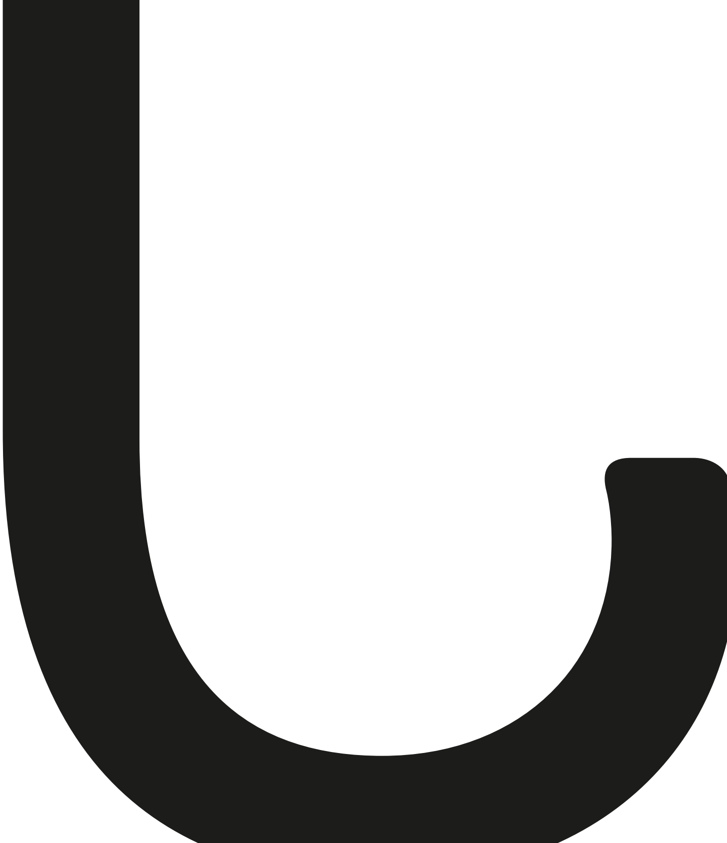


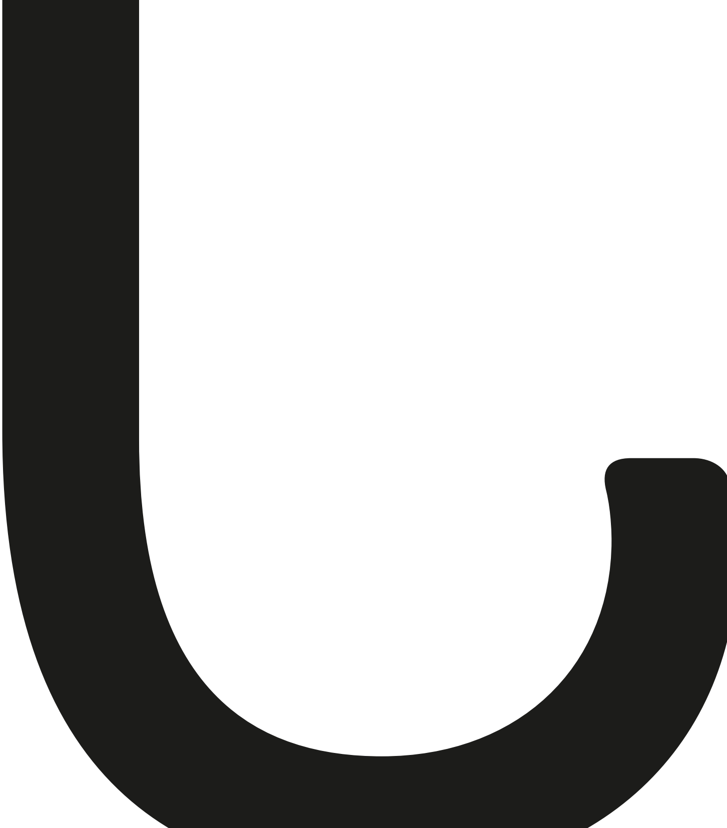
V



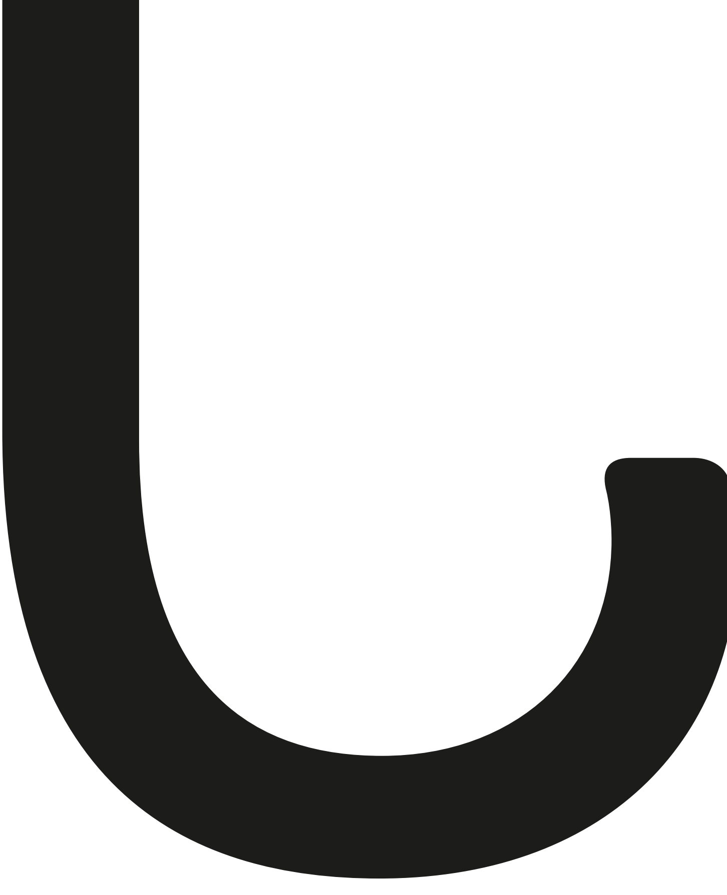








V

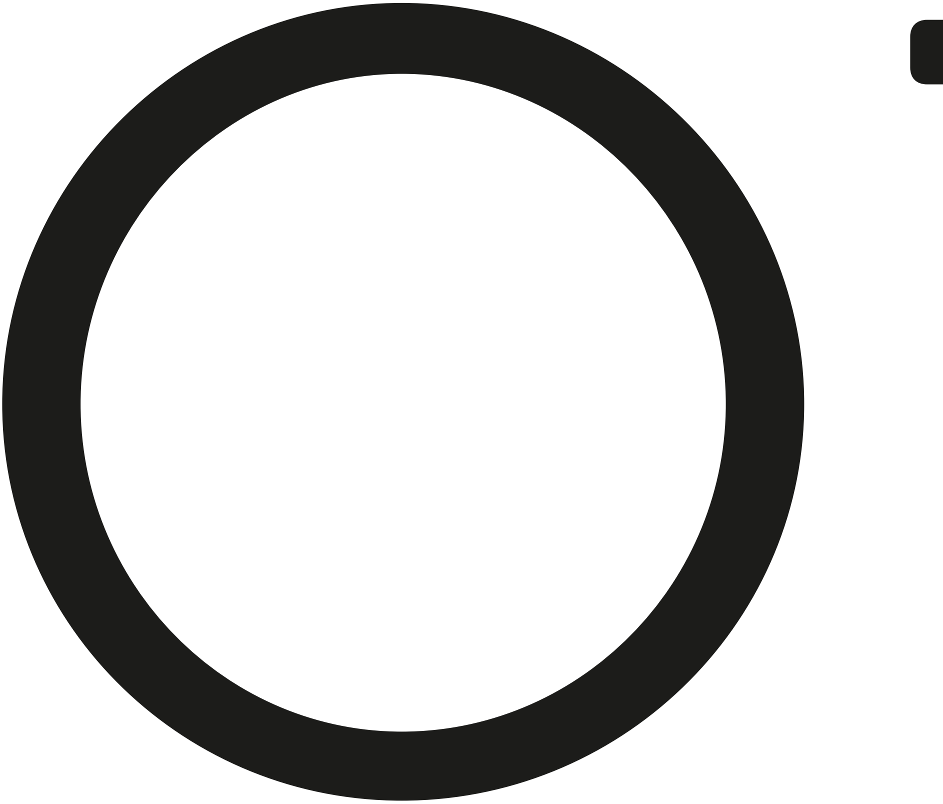


Le

tr

H

is



T

C

th

T

fr

P

n

ti

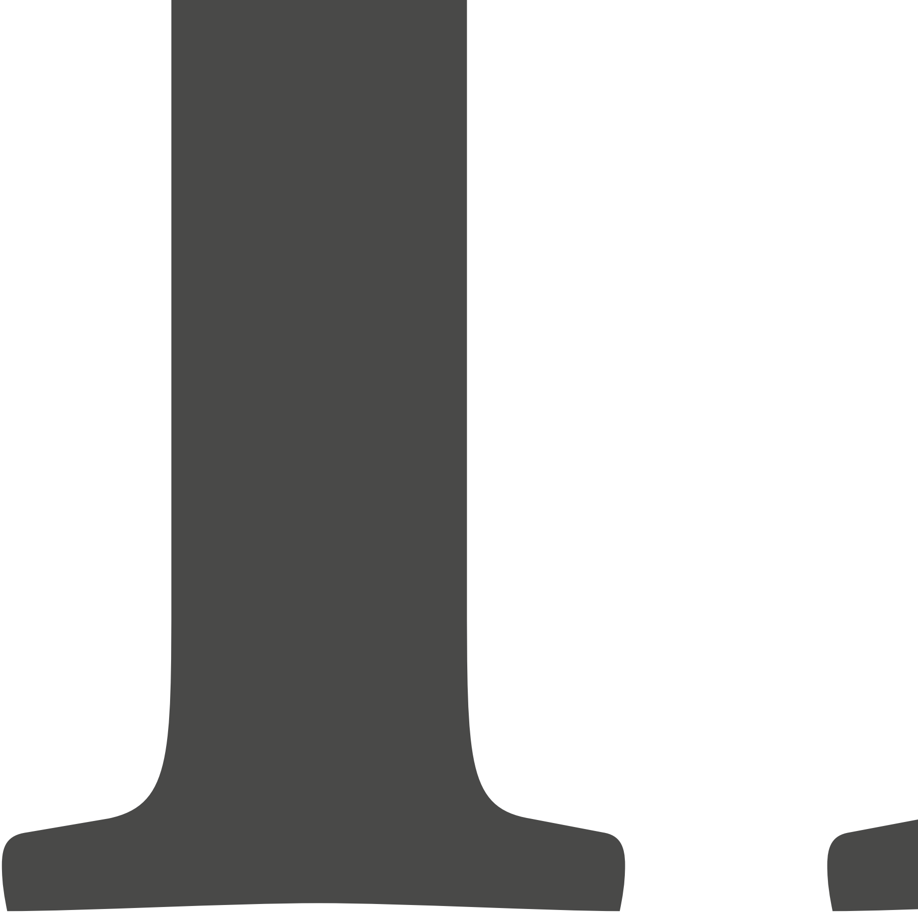
p

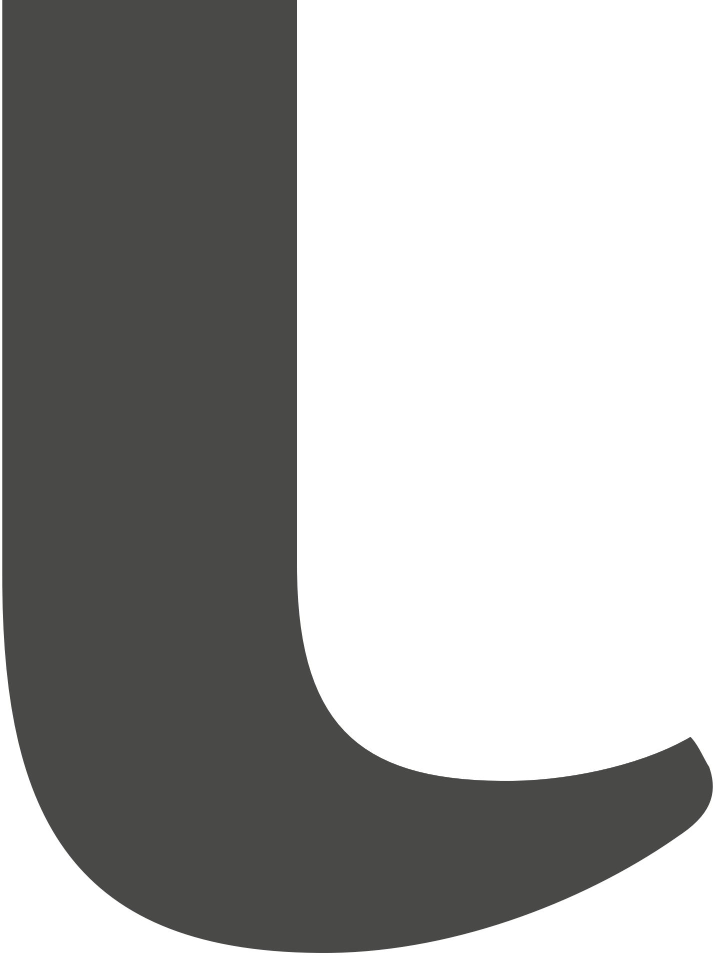
se

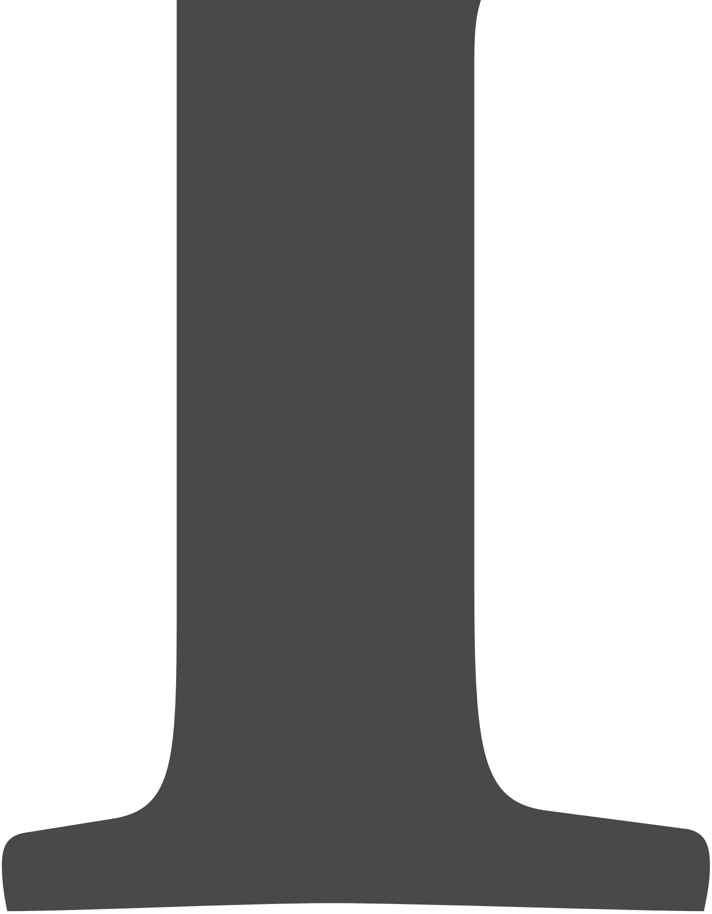
P

g

b

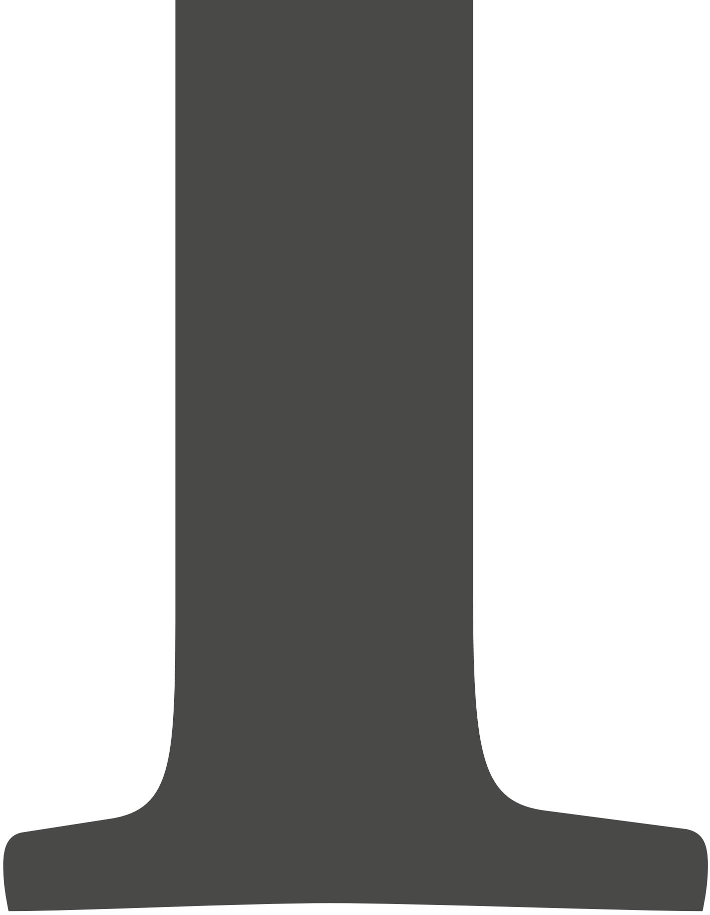


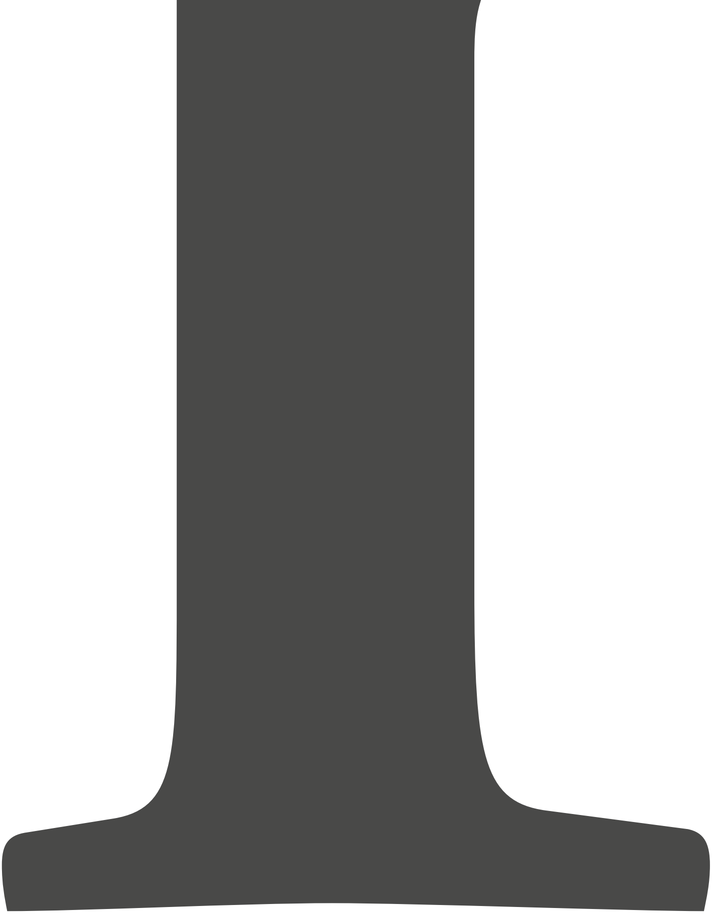


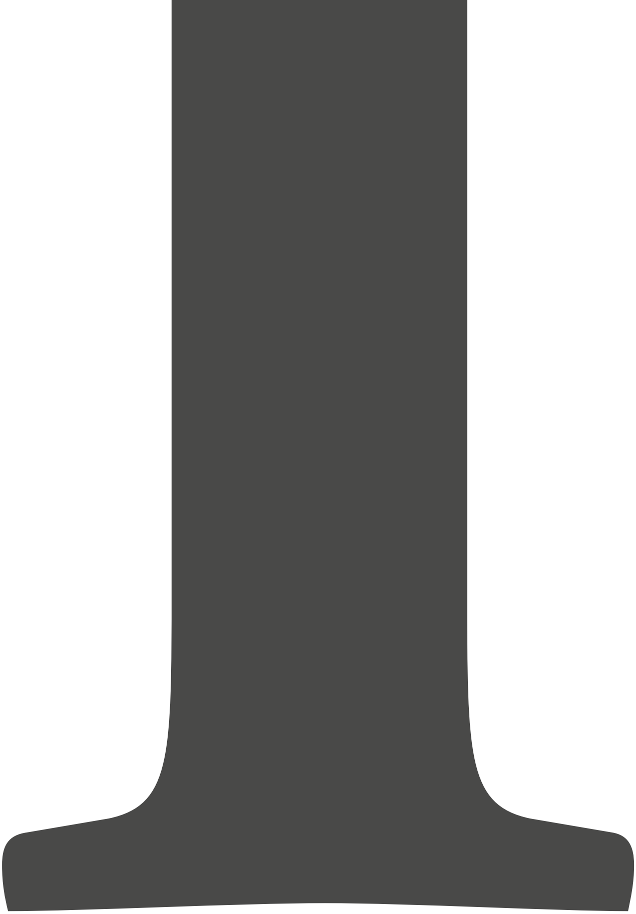


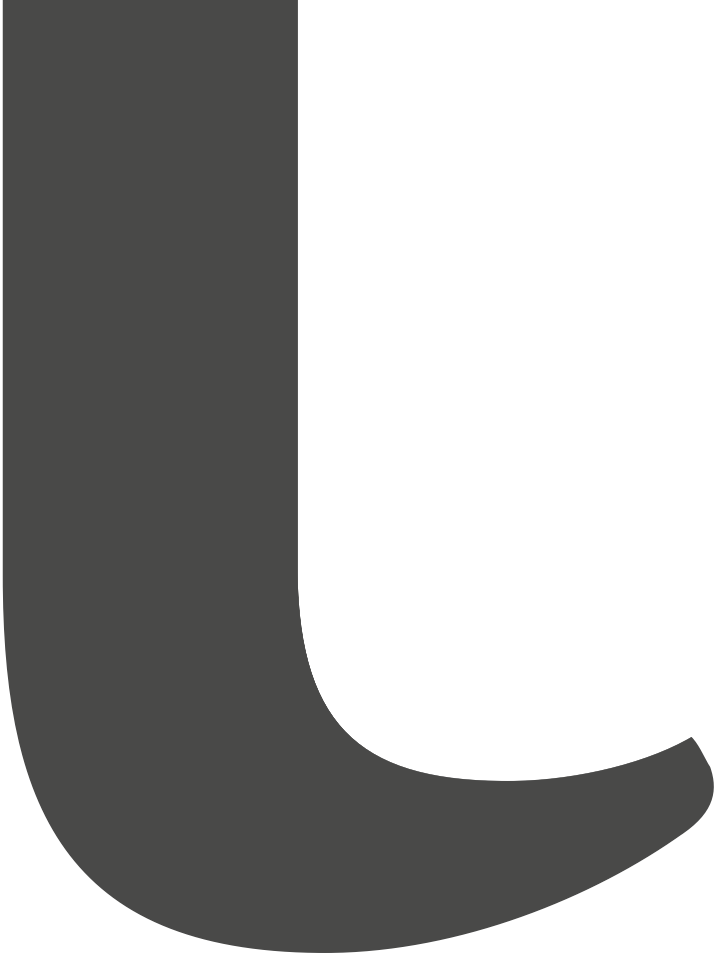
S

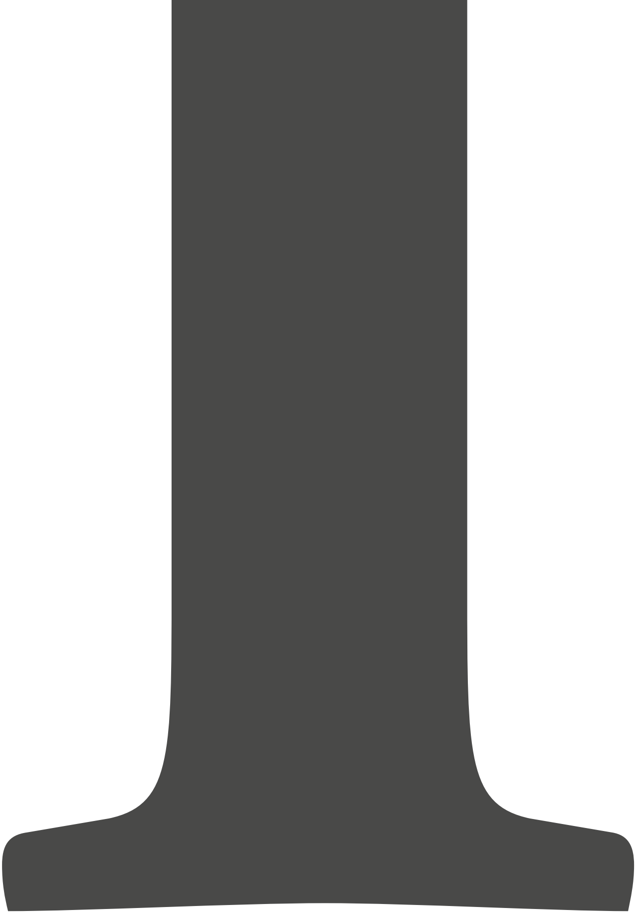
1

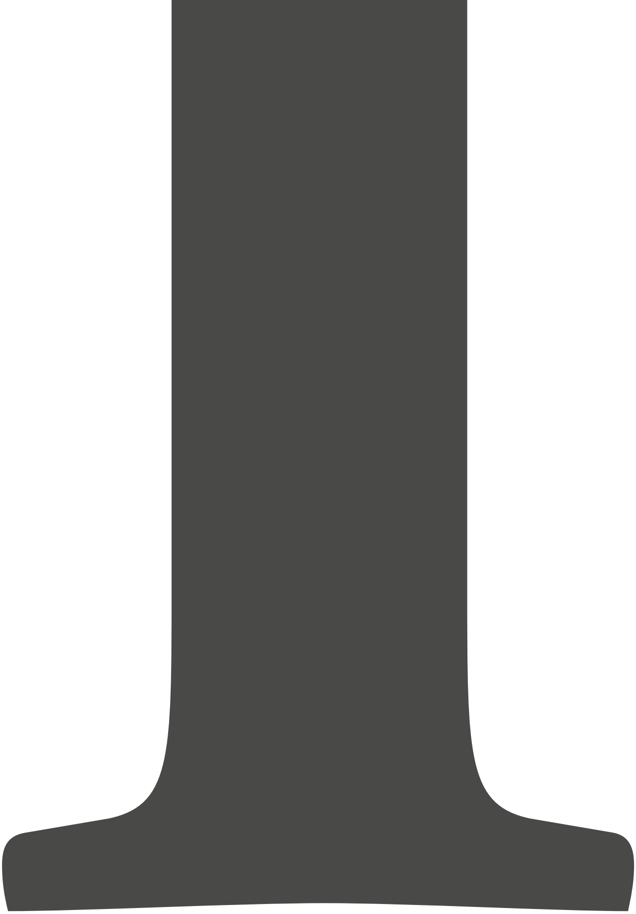




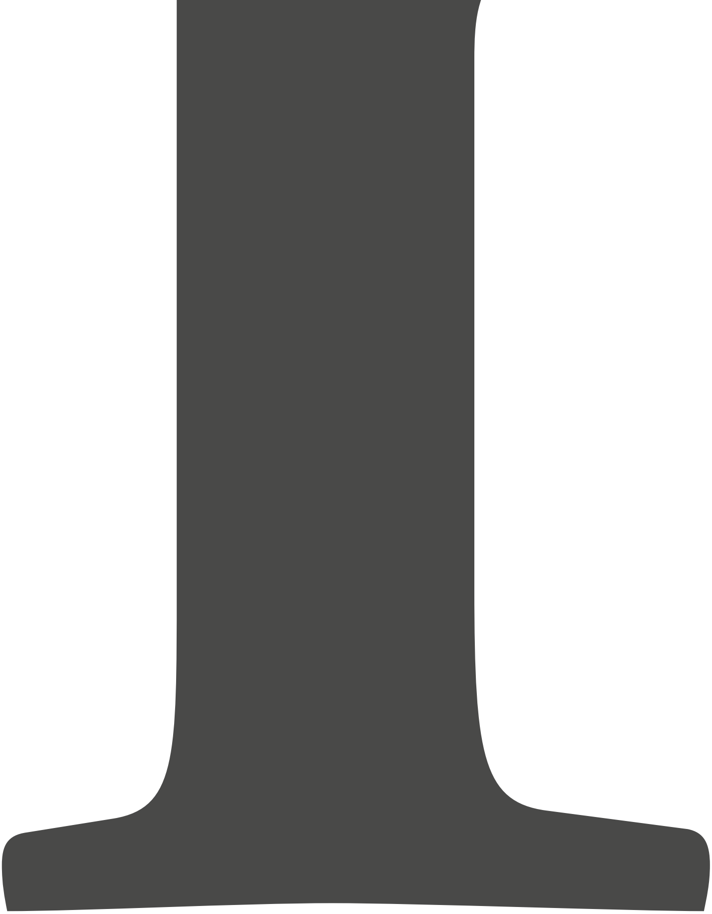


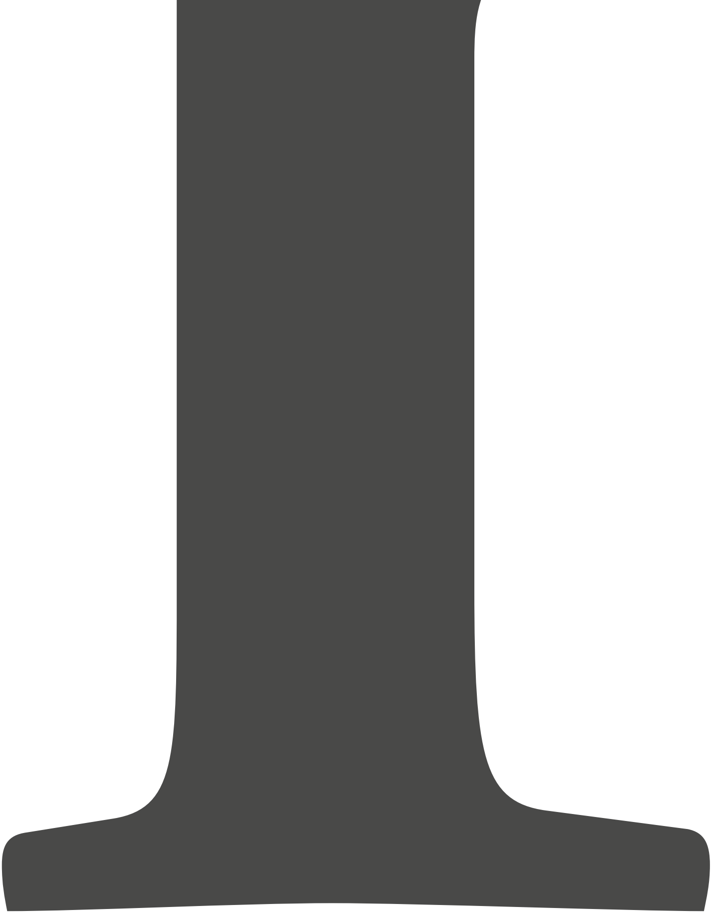


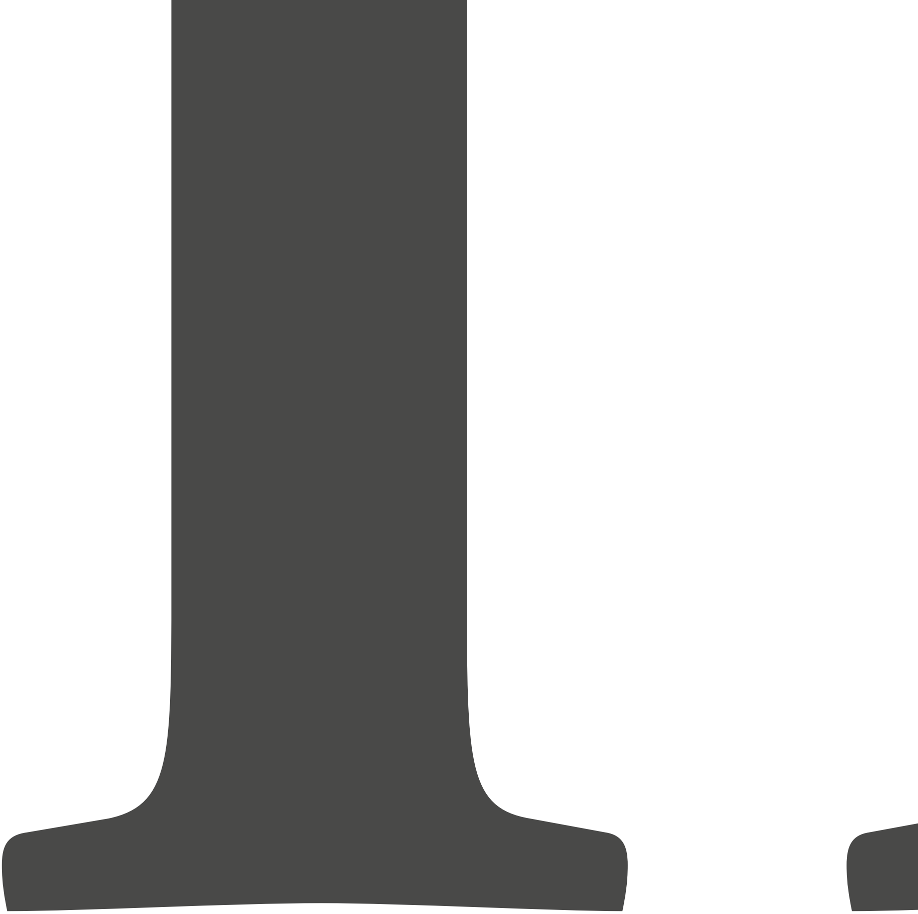


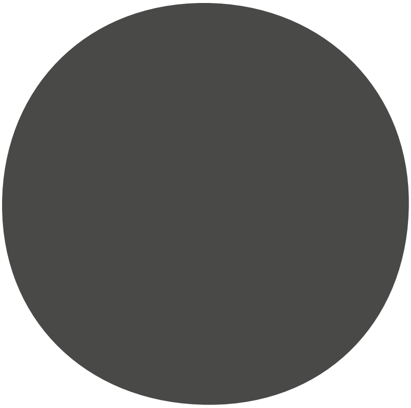


y

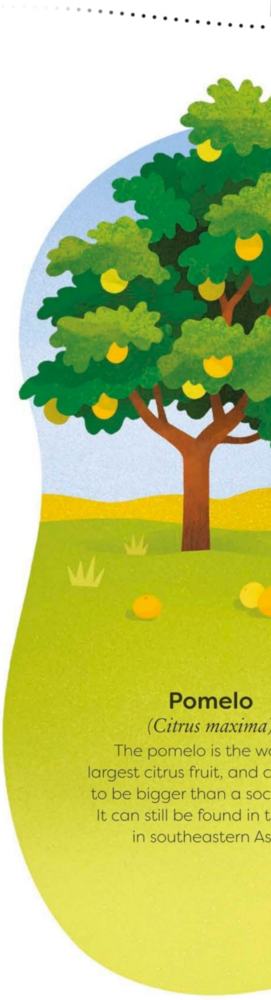








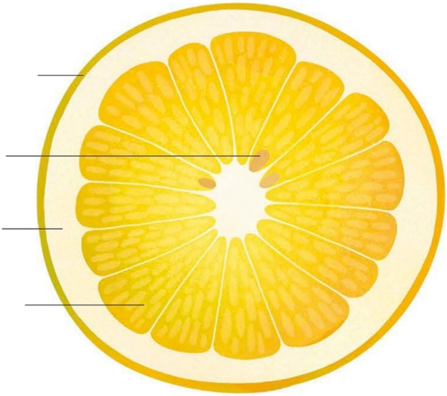
Pomelo



Pomelo

(Citrus maxima)

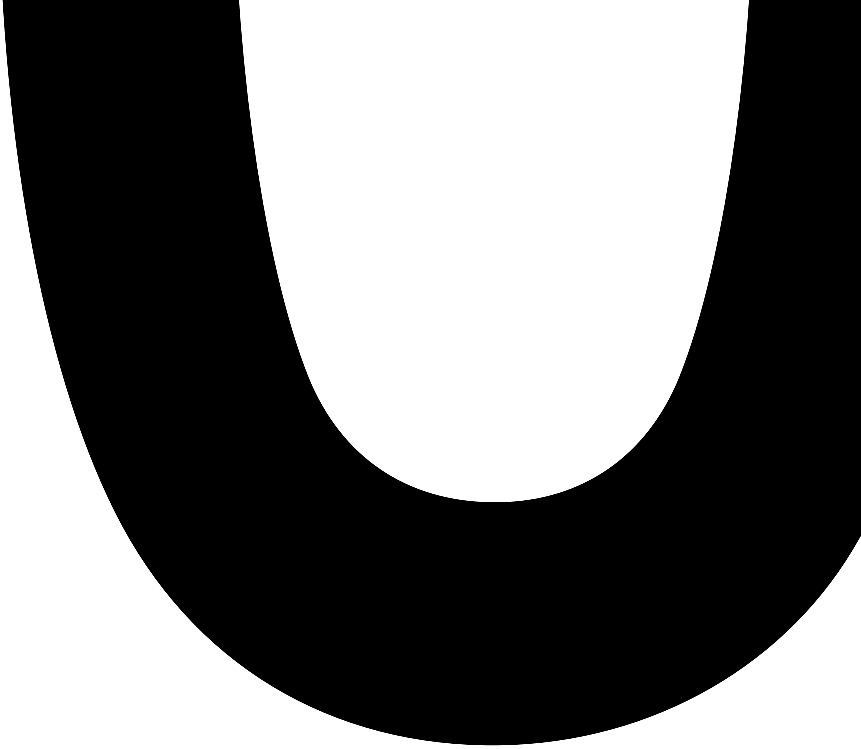
The pomelo is the wo
largest citrus fruit, and c
to be bigger than a soc
It can still be found in t
in southeastern As



Inside a citrus fruit

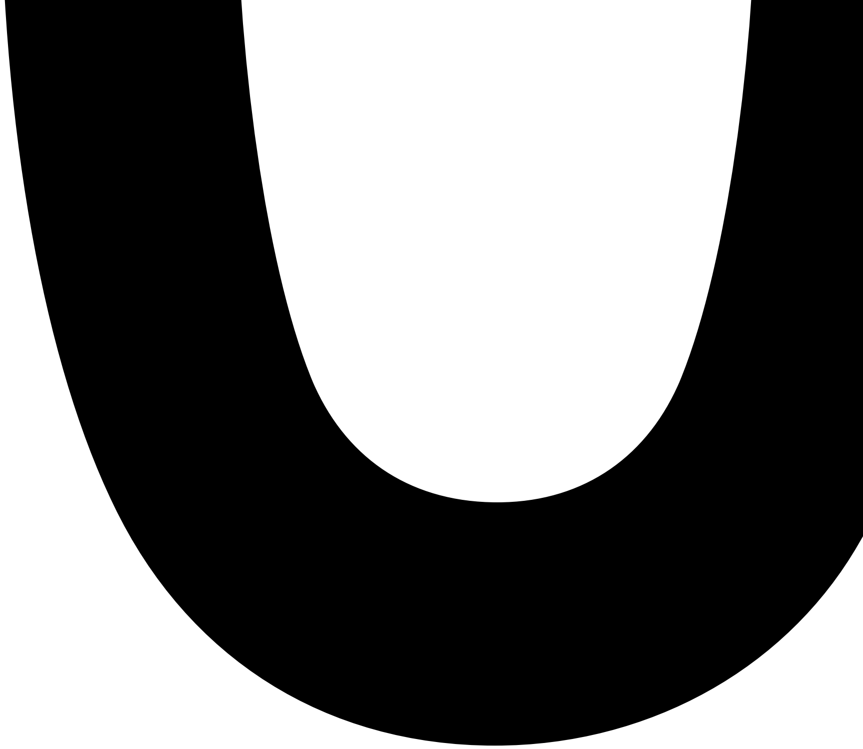
If you sliced a pomelo across the middle, this is what you would see. Under a layer of leathery skin, there is a white spongy cushion, called pith, which may be as thick as your thumb. The pith protects the segments of juicy flesh and the seeds, known as pips.

[redacted]



IV

L



lf

m

U

a

w

T

ju

a

T

l

t

lt

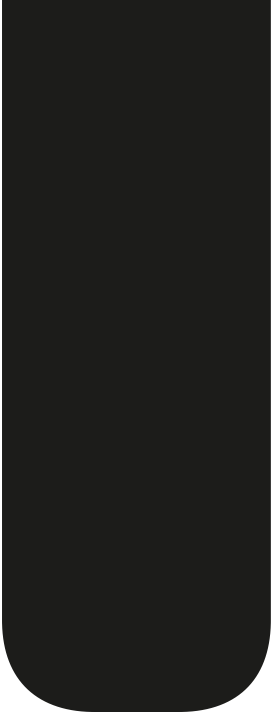
in

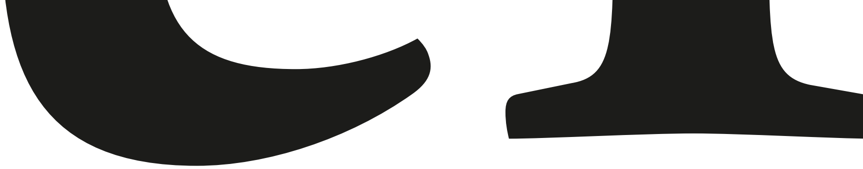
S

P

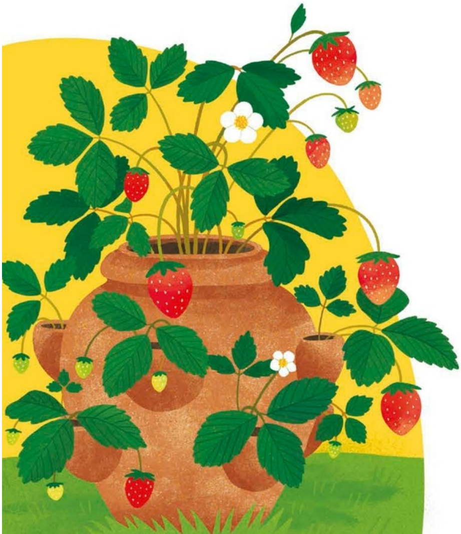
P

F





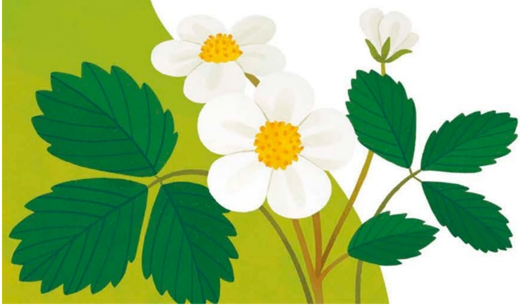
Strawberry

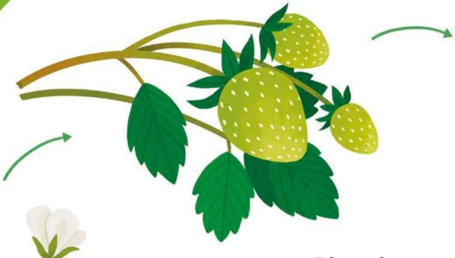


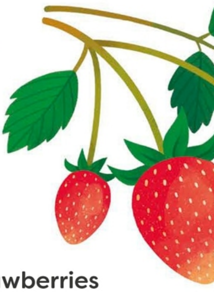
Strawberry

(Fragaria x ananassa)

This is the strawberry plant we usually grow. It is a cross between two wild species, one from North America and the other from South America.

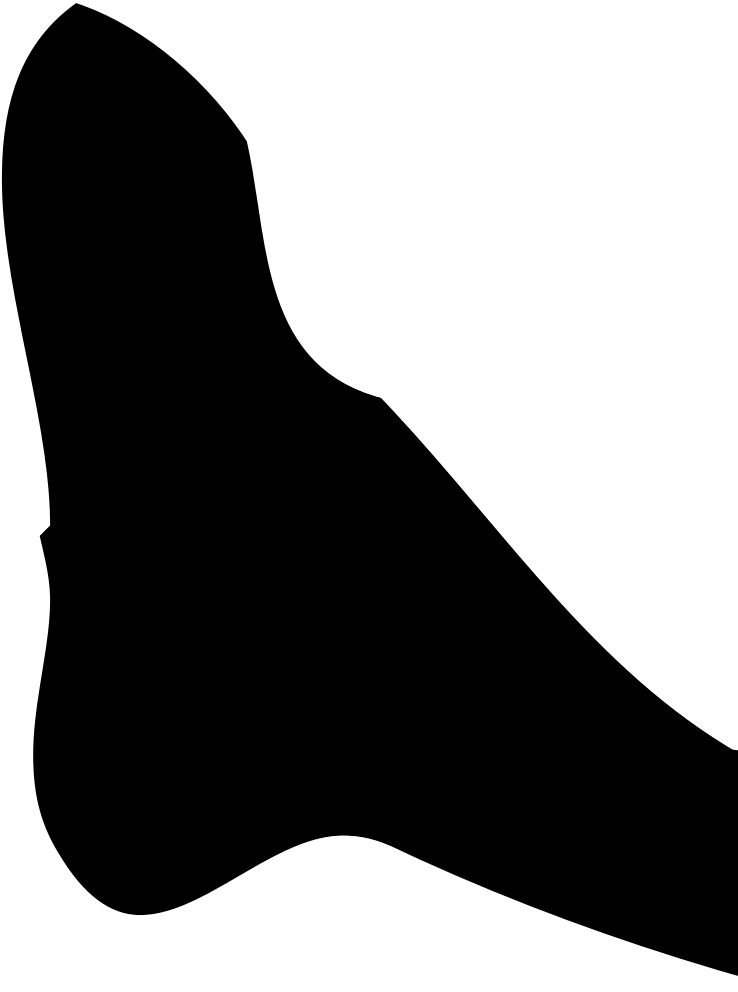


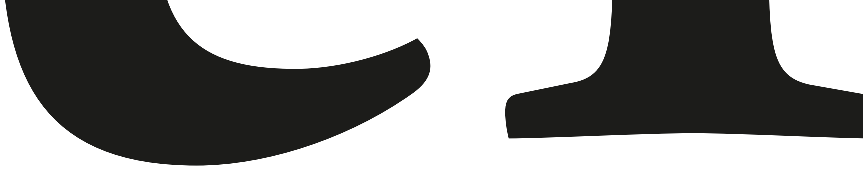




Ripening strawberries

Strawberry plants produce fruit in an unusual way. Every flower contains many ovaries. When each ovary is pollinated, it makes a hard, yellow fruit attached to a fleshy stem. As they grow, the stems join together to create a single strawberry. At first, the flesh is green, but as it ripens, it turns red.





S

w

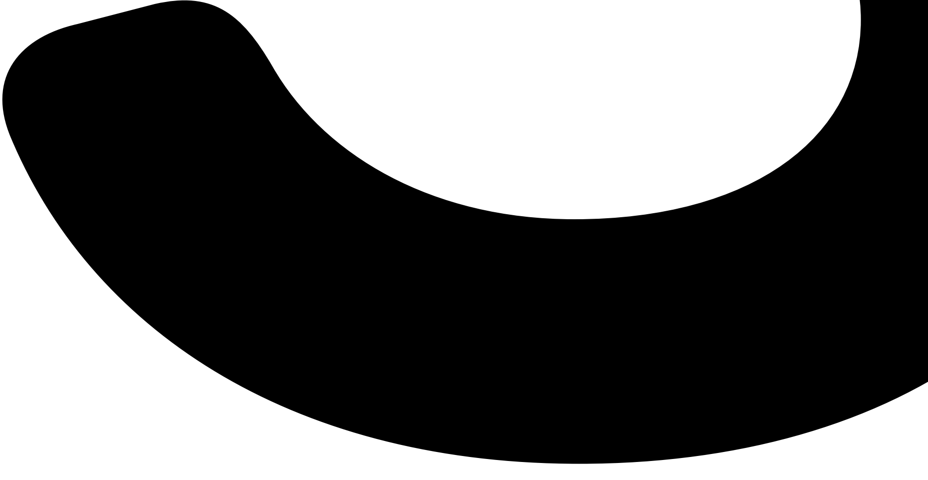
e

fr

th

st

a

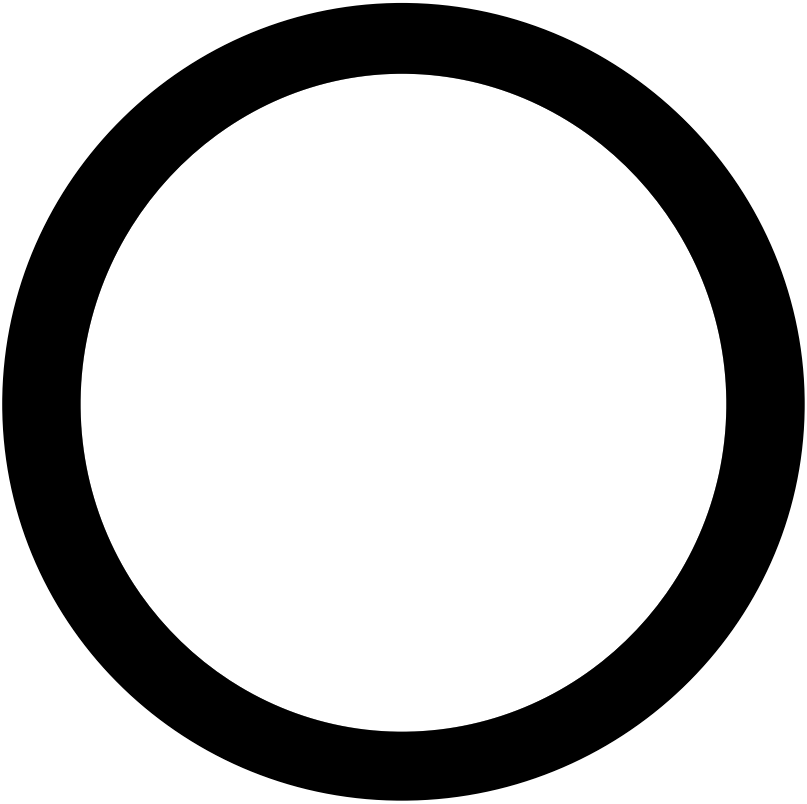


T

w

b

fr



F

U

R

[redacted]

D

[redacted]

T

st

e

fl

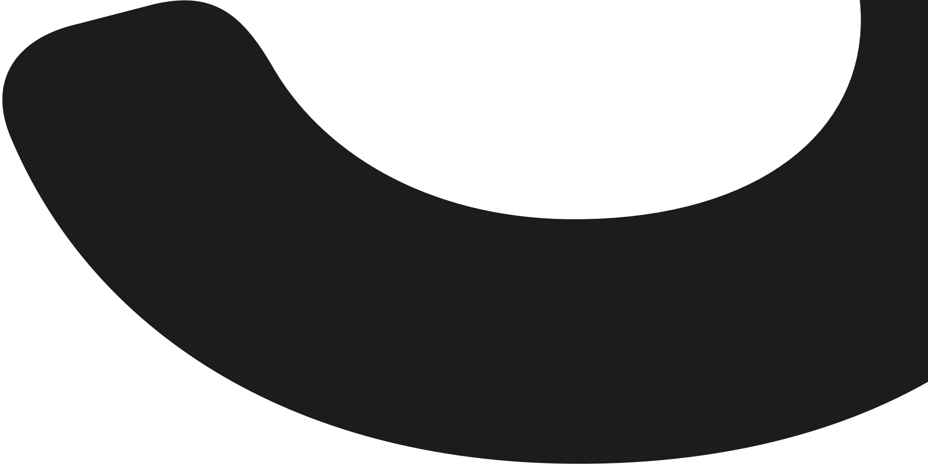
a

T

ye

in

st



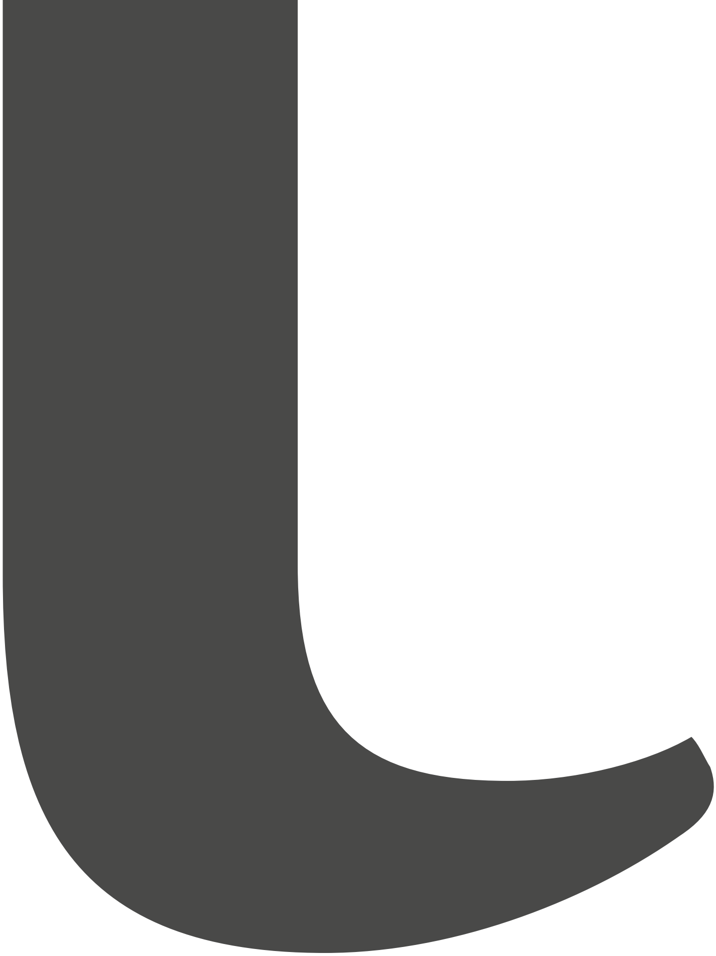
S

S

te

b

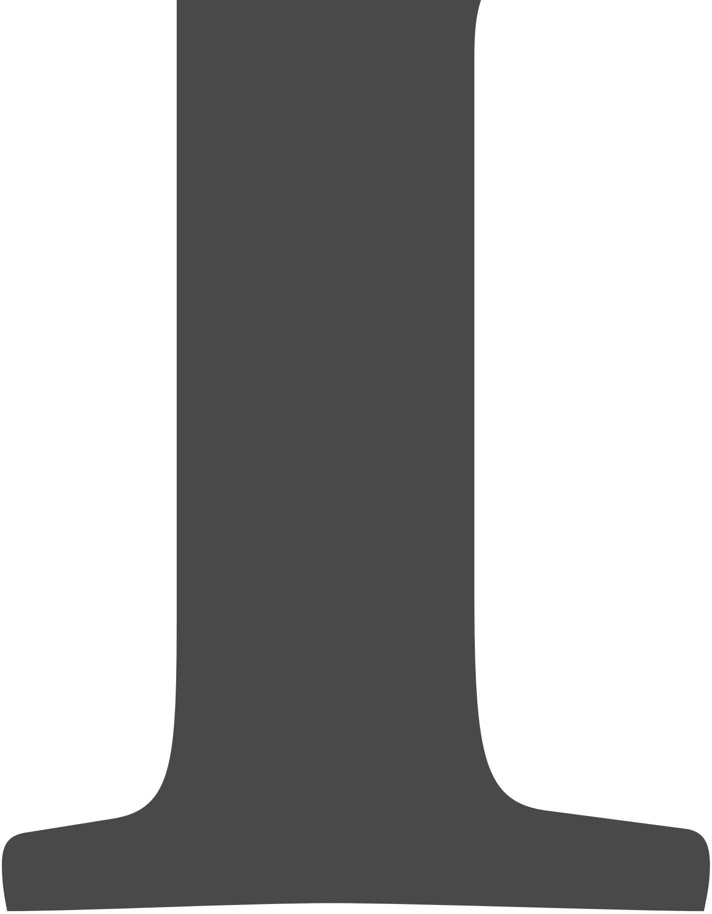
W



1

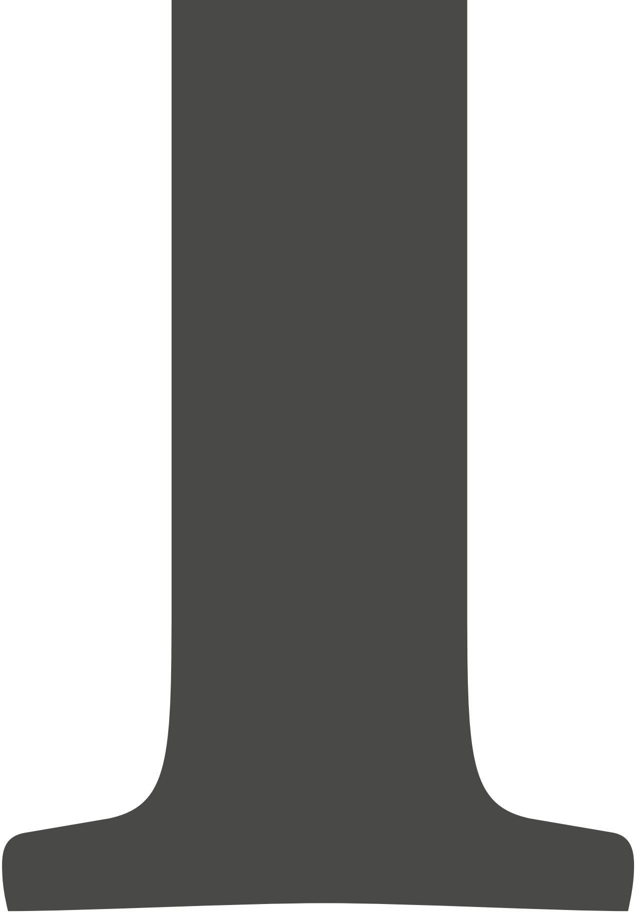
a

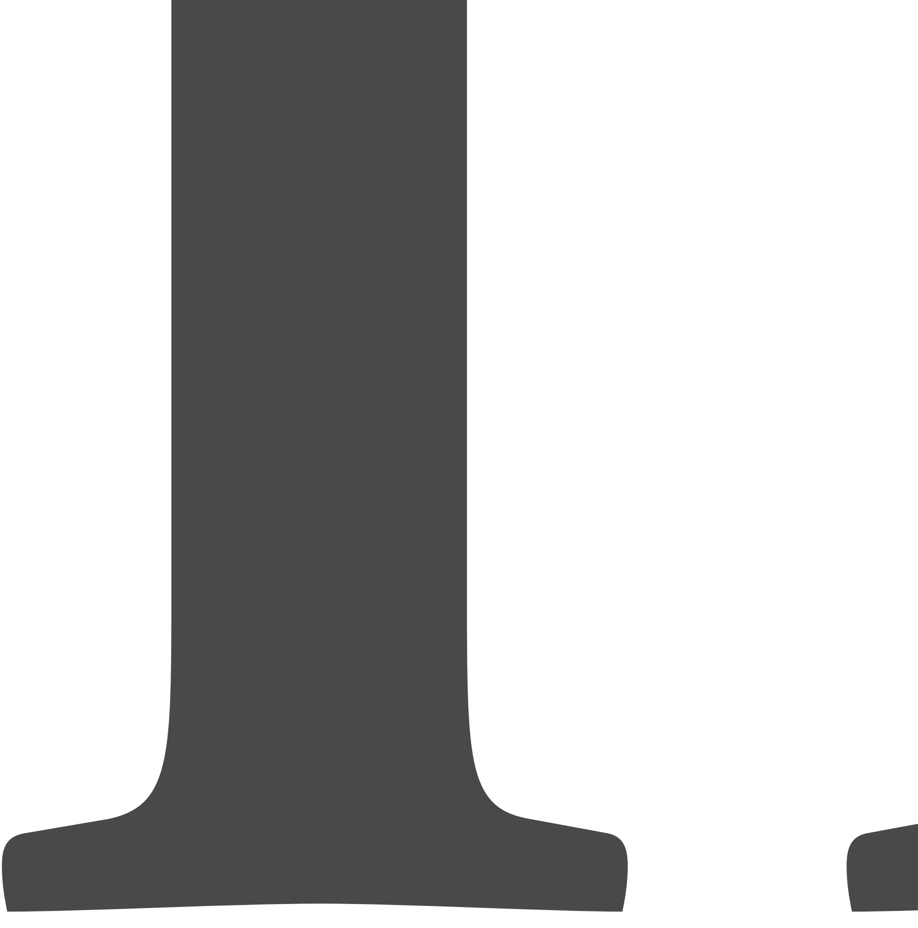
V

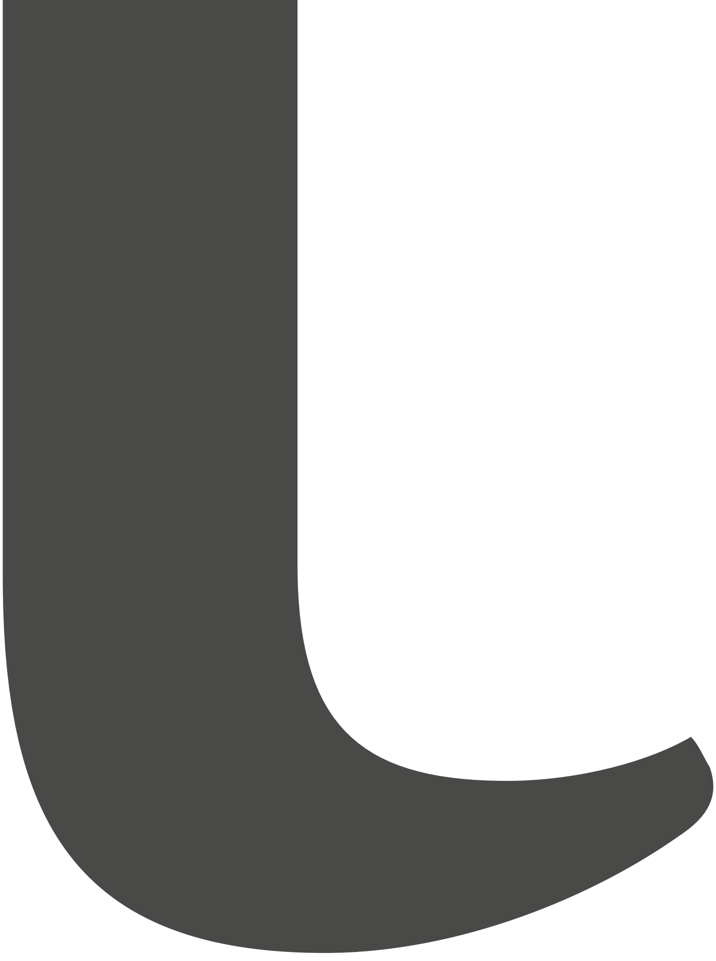


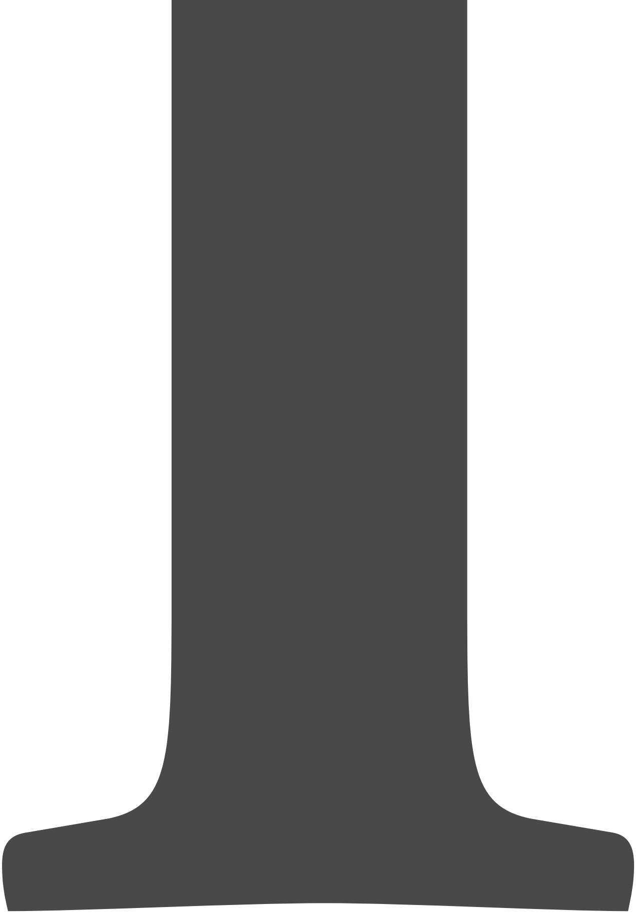
1

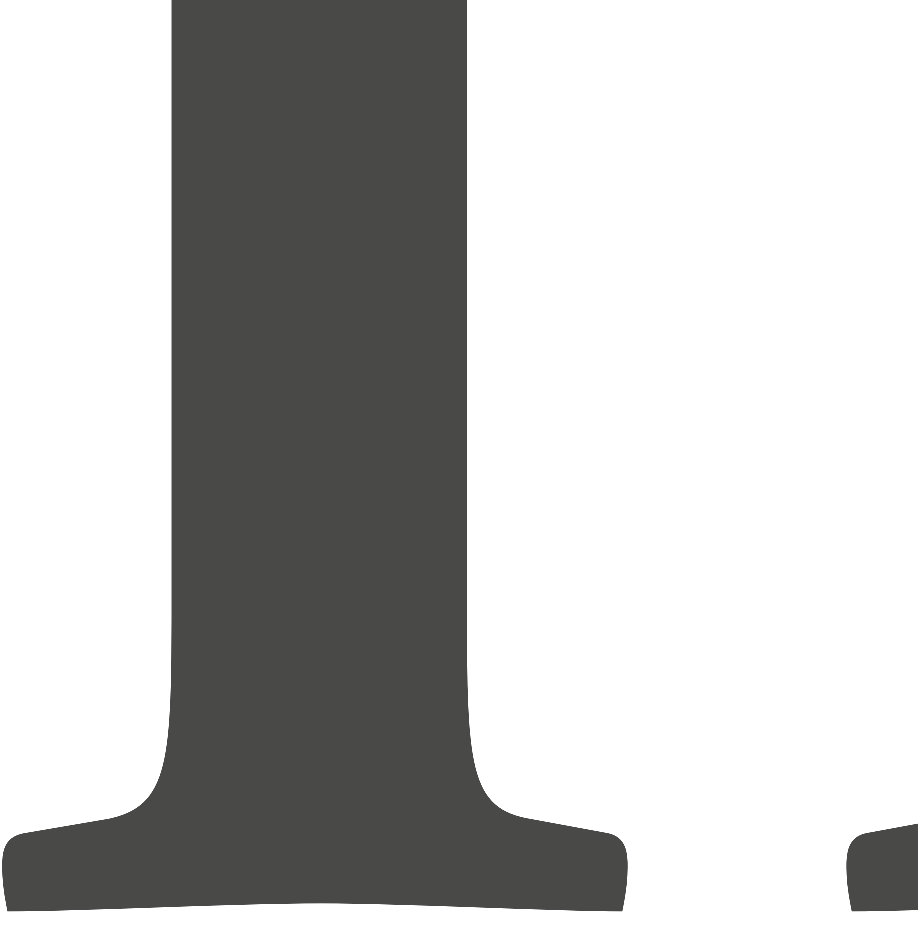
y

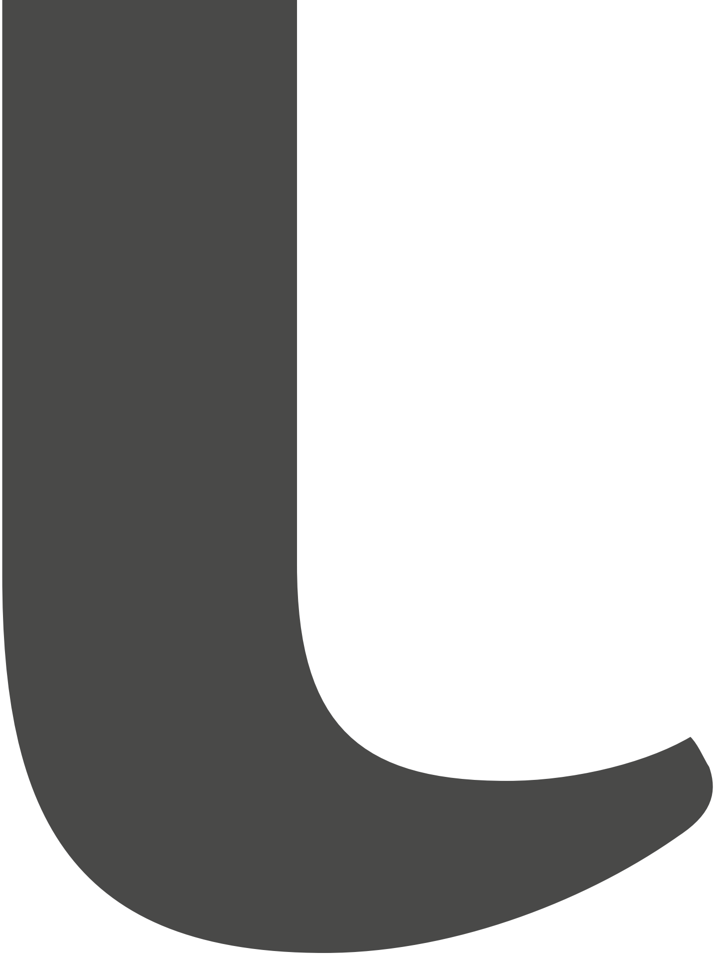


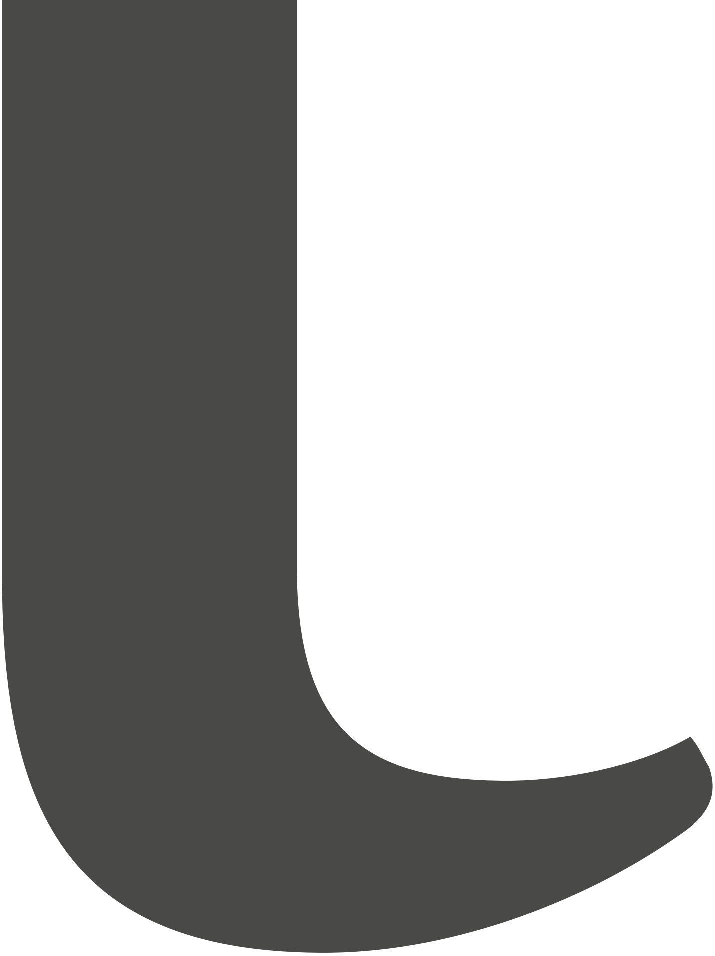


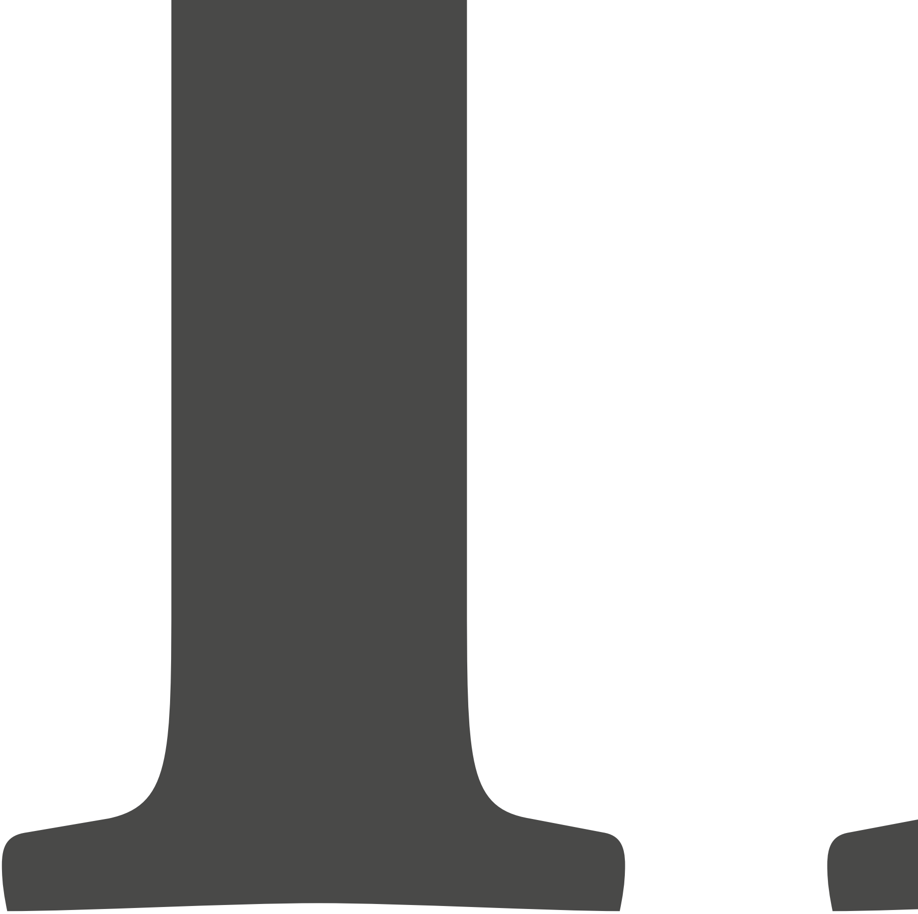


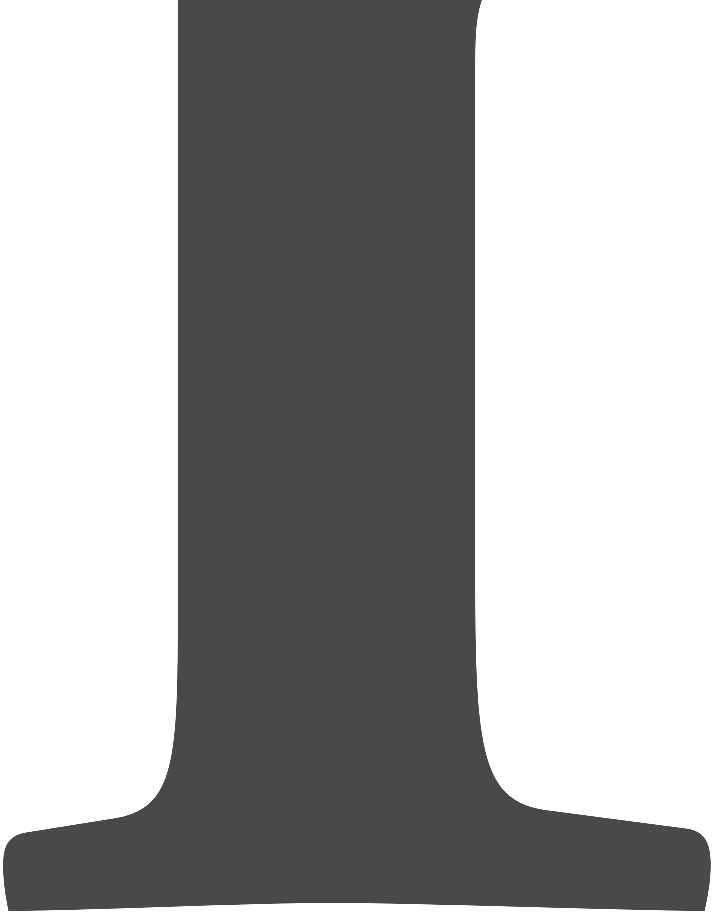


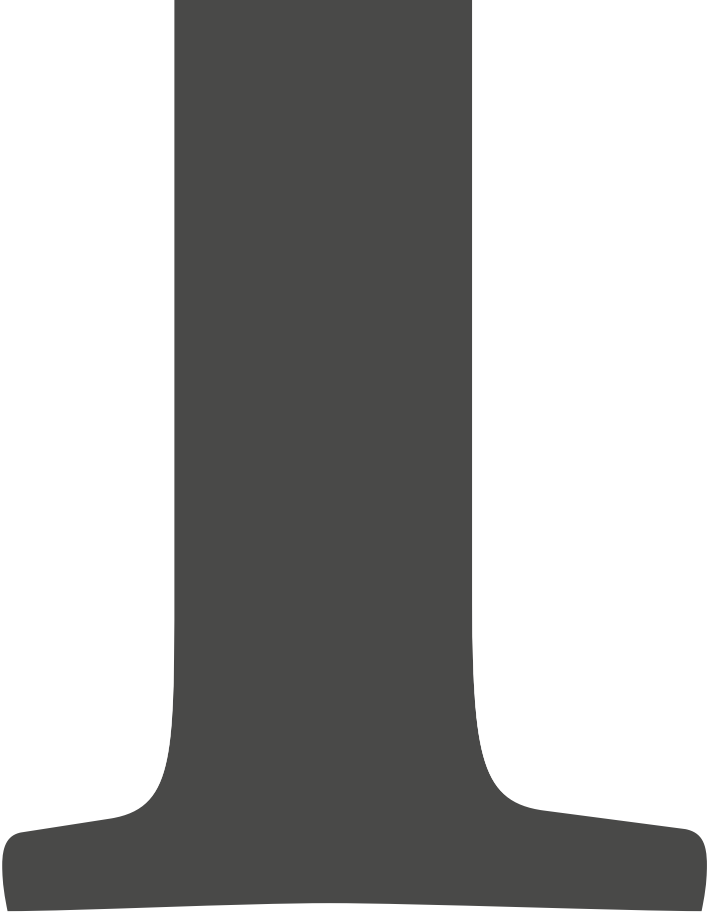




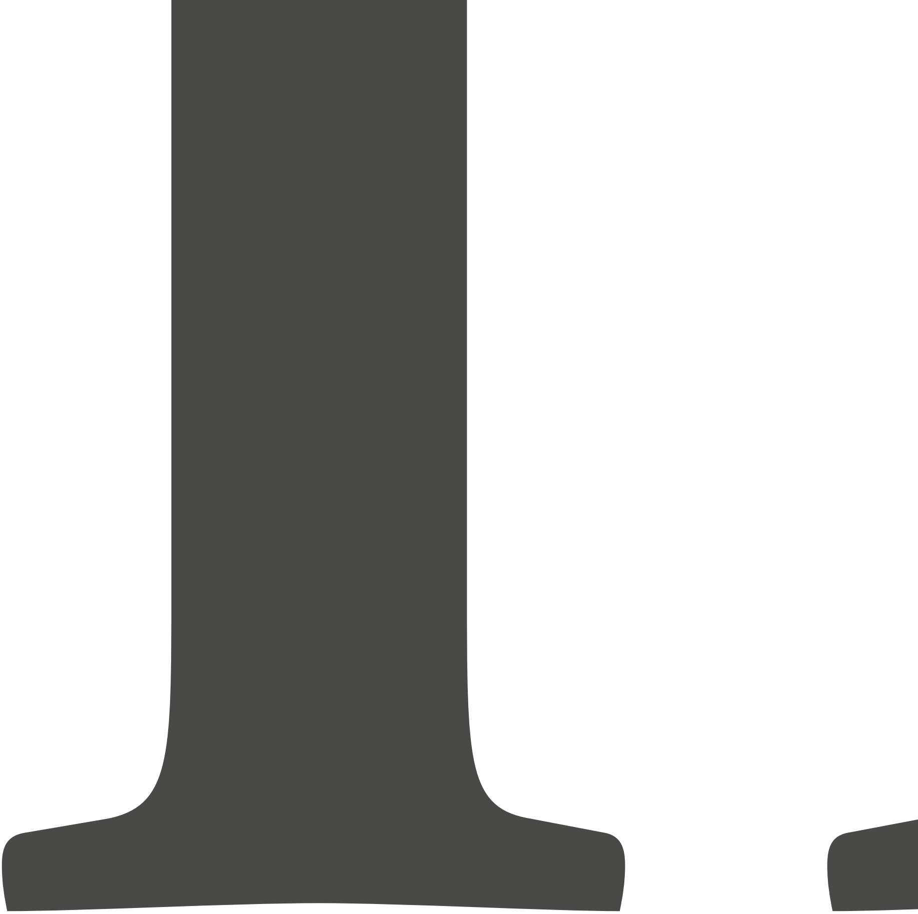


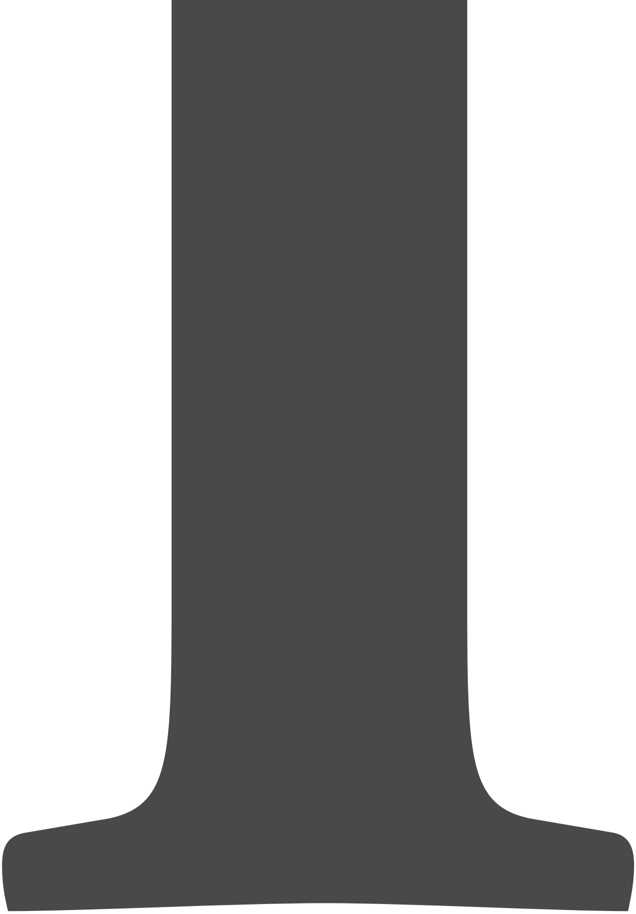


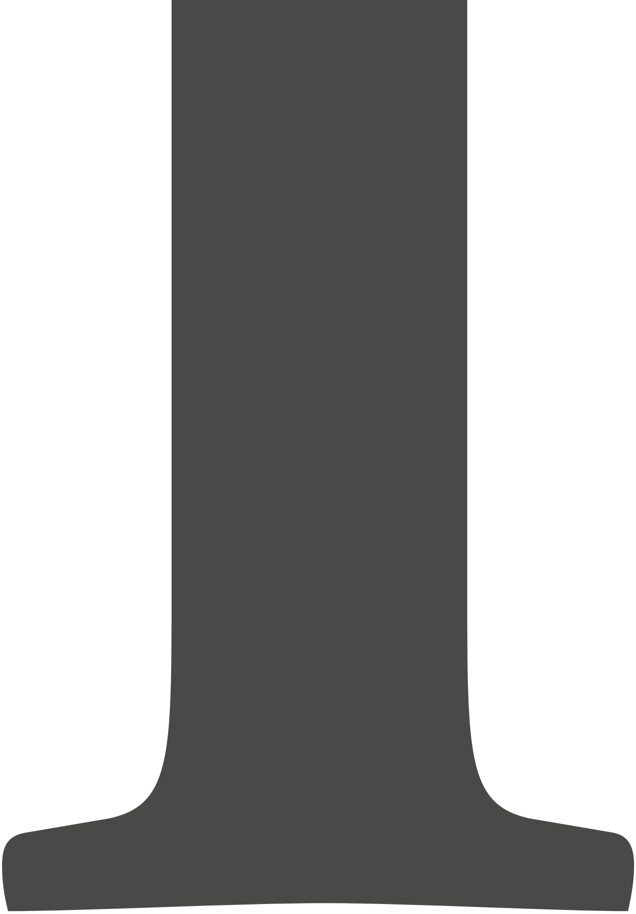




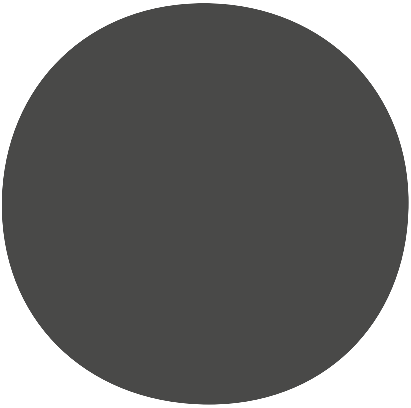
a







y



Useful fruits

T

fr

fl

h

m

W

T

lik

a

r

b

T

a

fu

lik

a

J

th

g

te

a

B

se

st

l

S

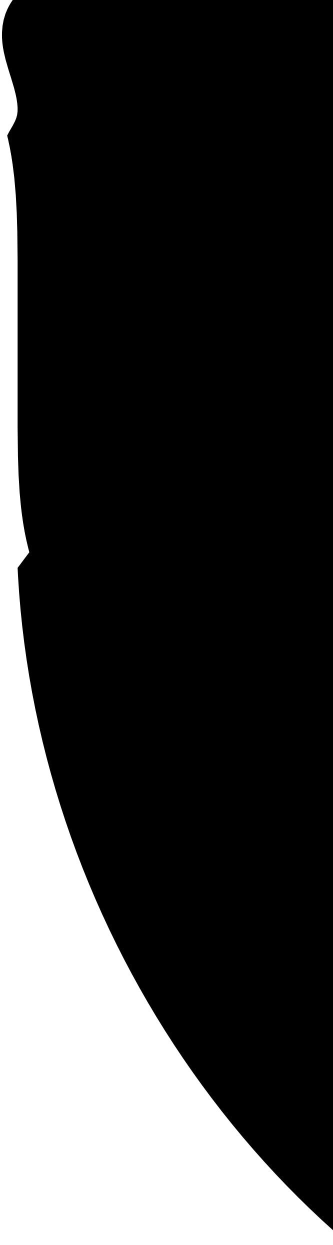
T

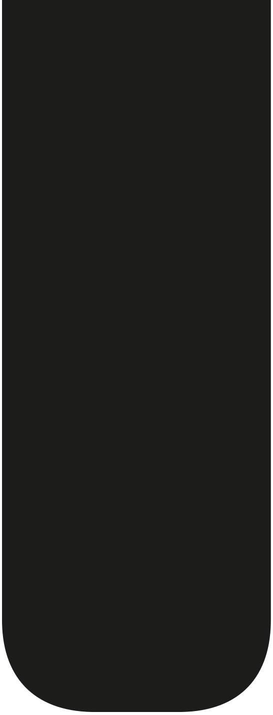
C

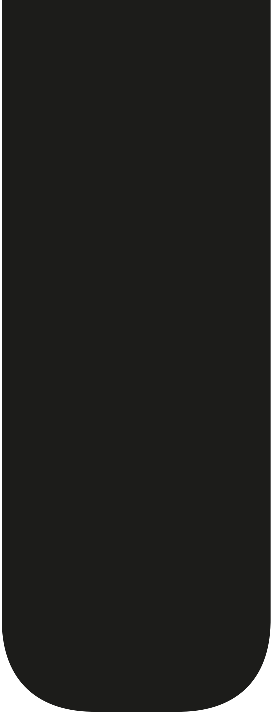
d

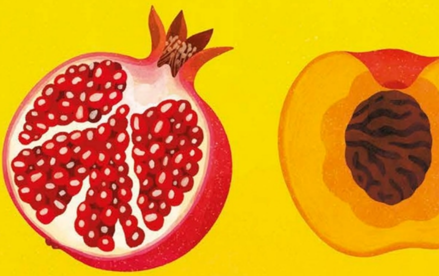
C

sr









Seeds or stone?

Most fruits contain many seeds—pomegranates, fo
example, have several hundred. Other fruits, such a
peaches, have a single, inedible, rock-hard seed, kno
as a stone. They are called stone fruits, or drupes.

U

[redacted]

U

L

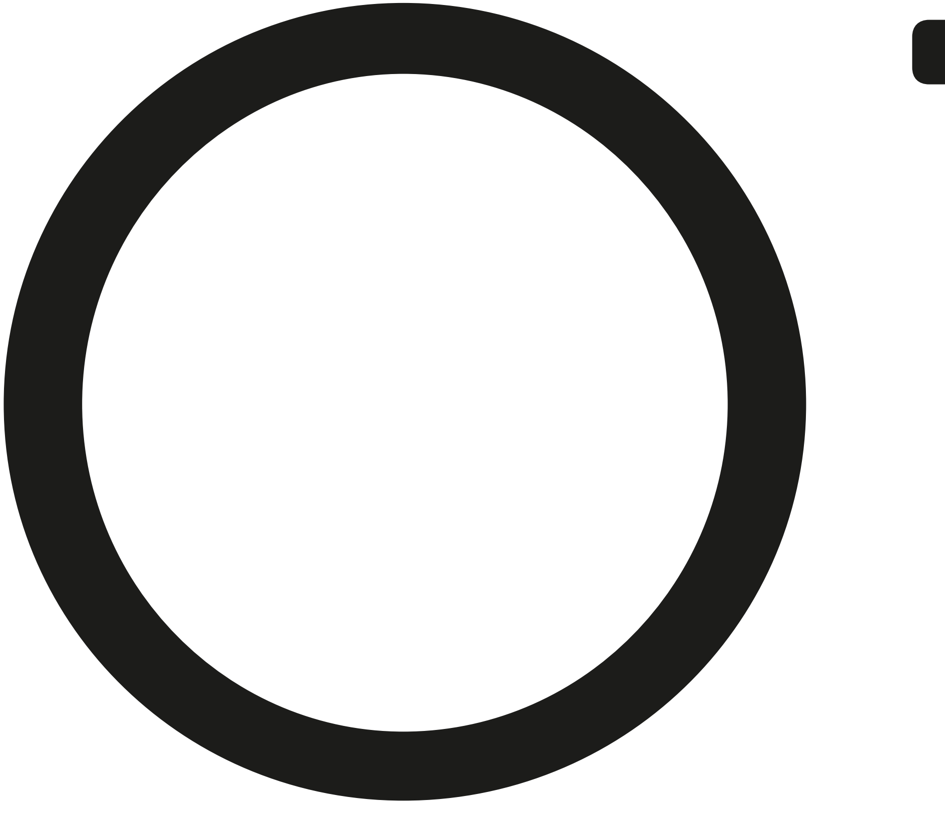
U

[redacted]

[redacted]

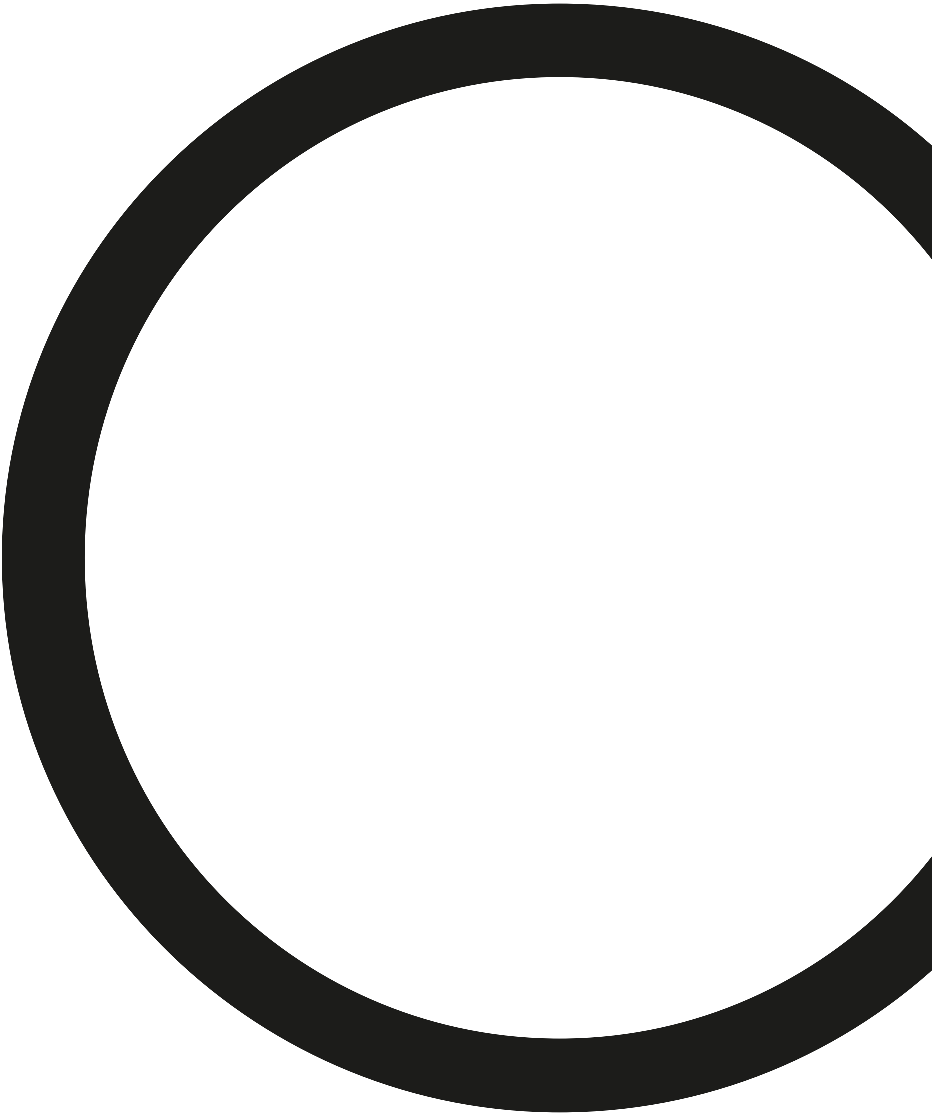
T

E



P

S



ro

h

b

w

P

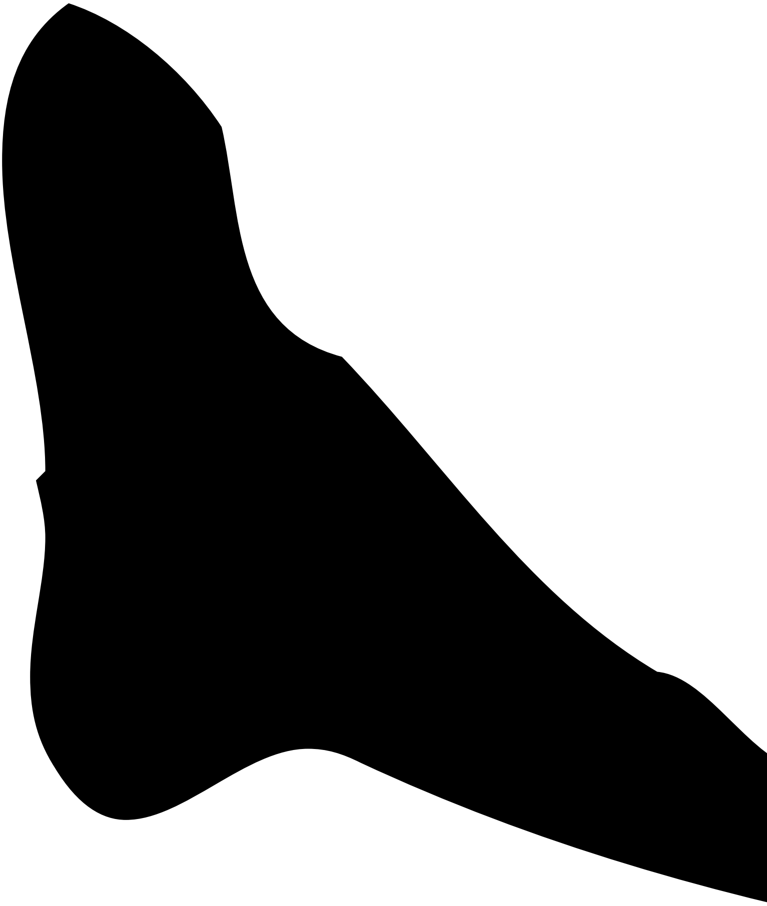
P

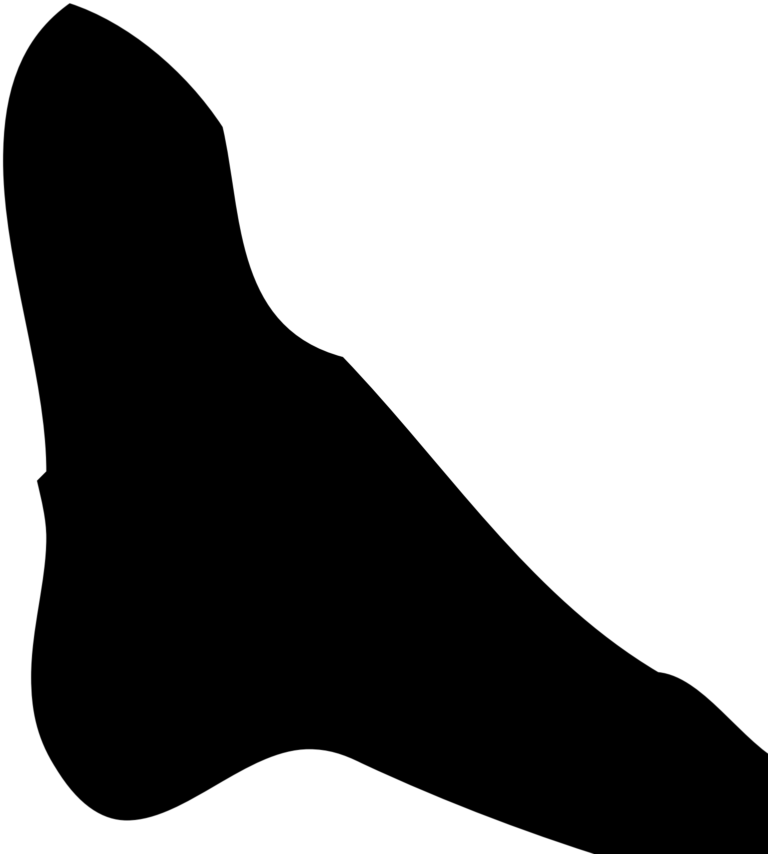
R

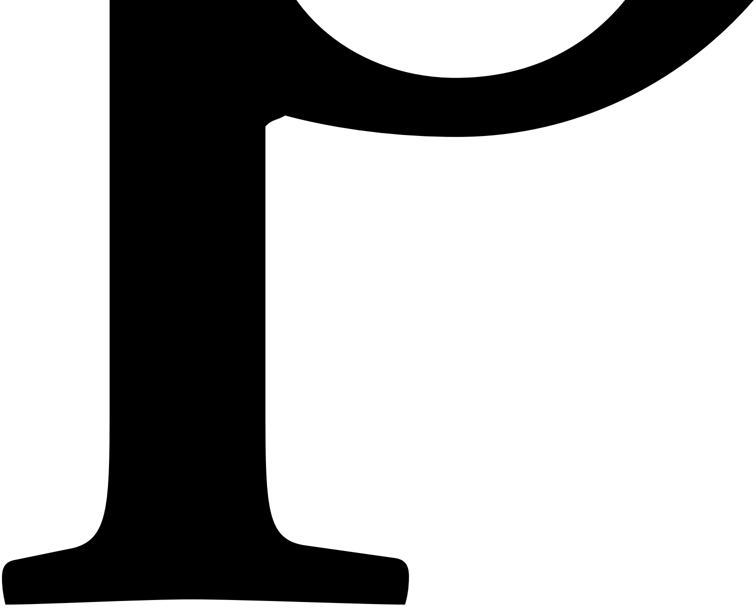
h

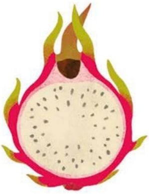
Pi

sh









T

fl

a

T

lo

a

G

th

le

p

T

m

S

m

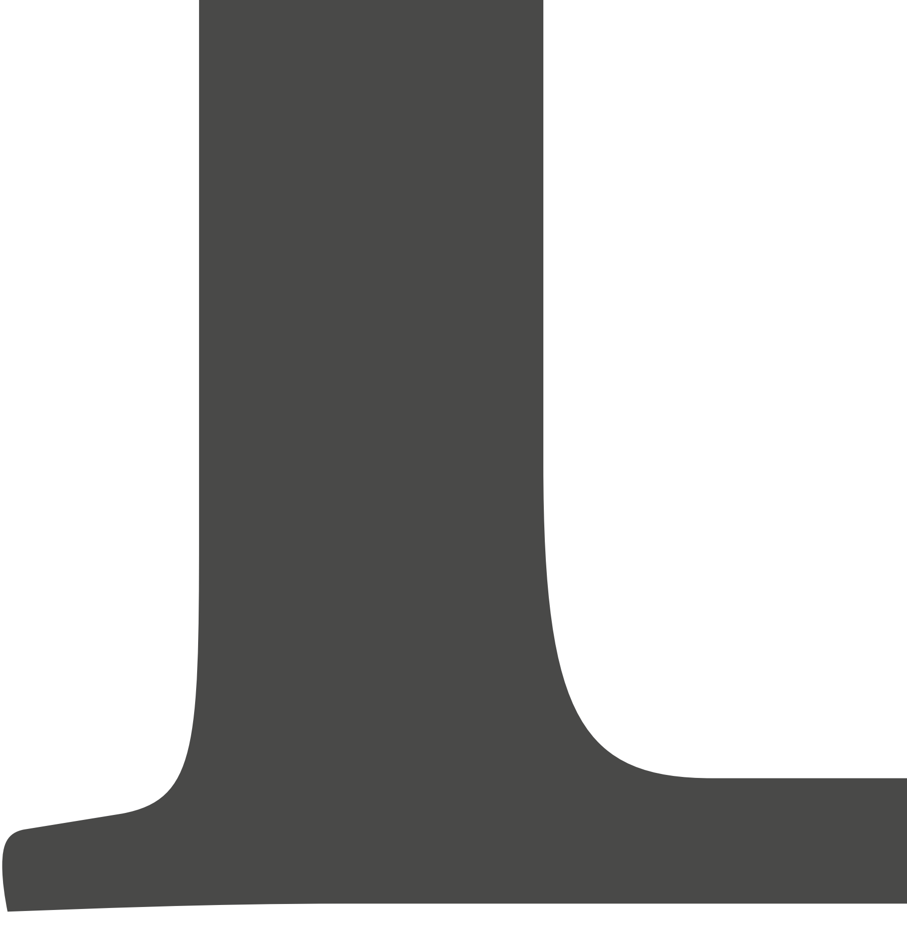
T

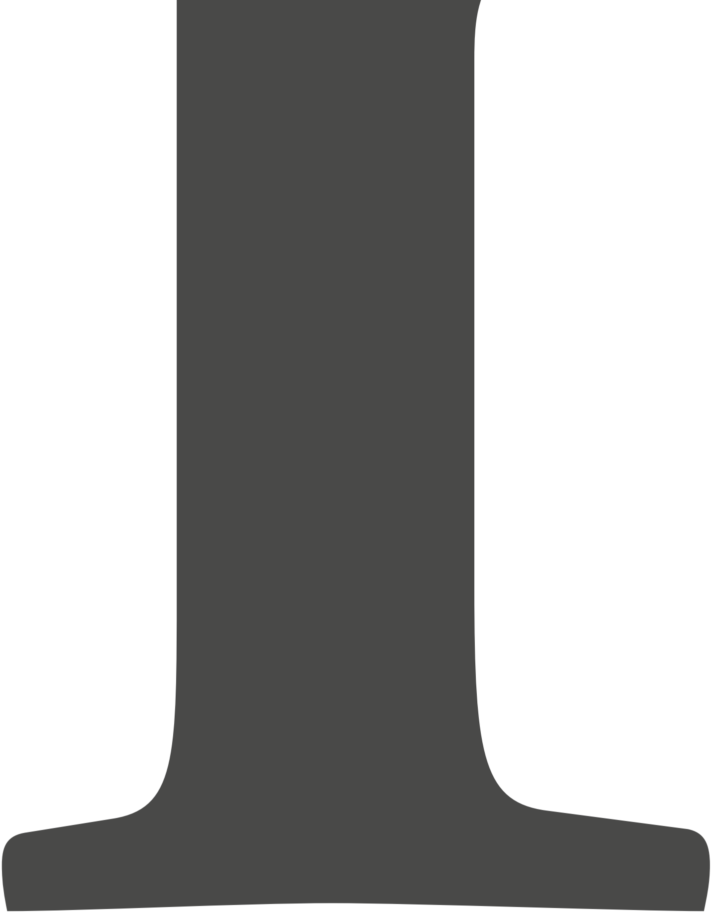
is

a

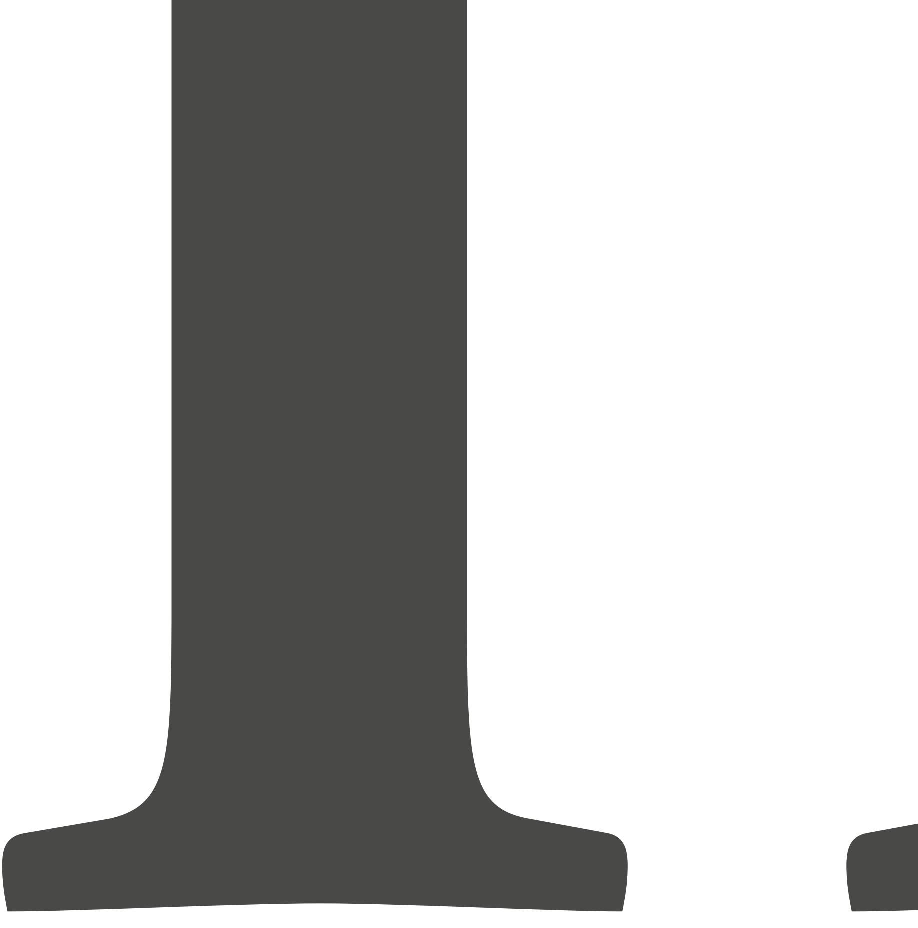
W

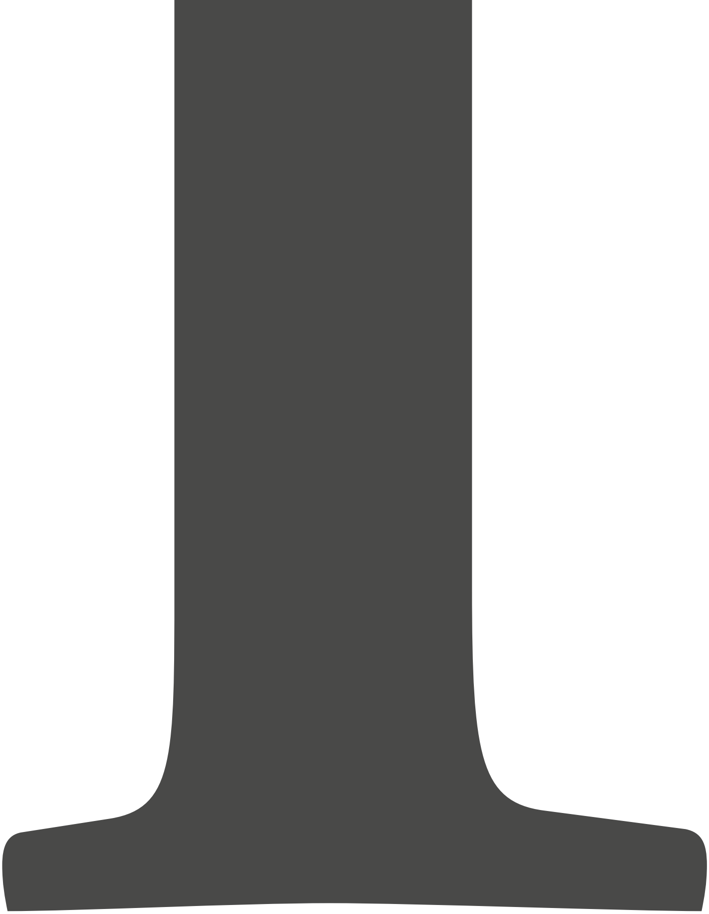
a

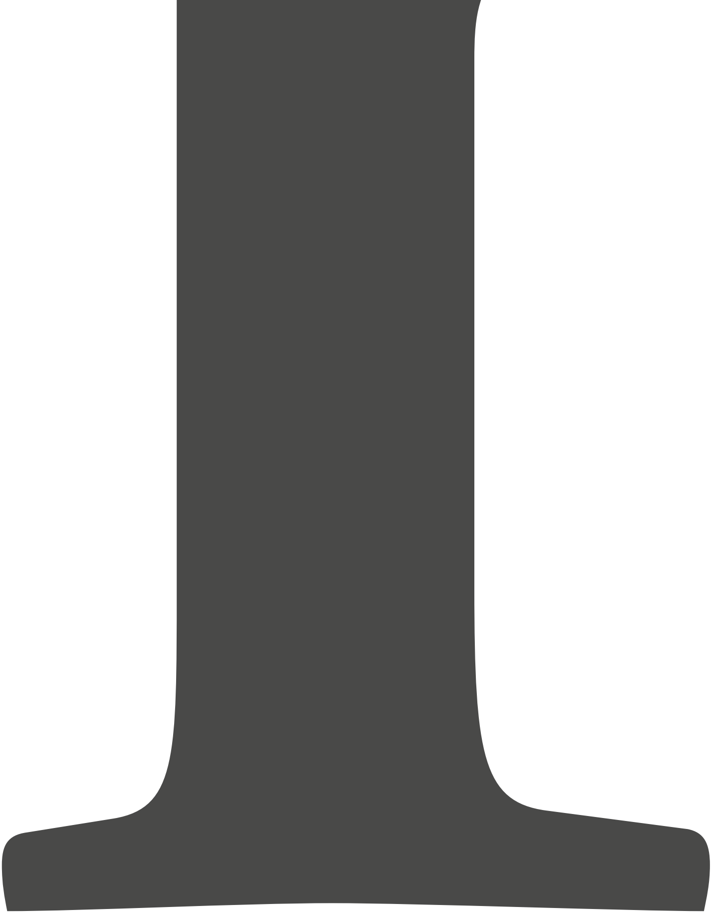


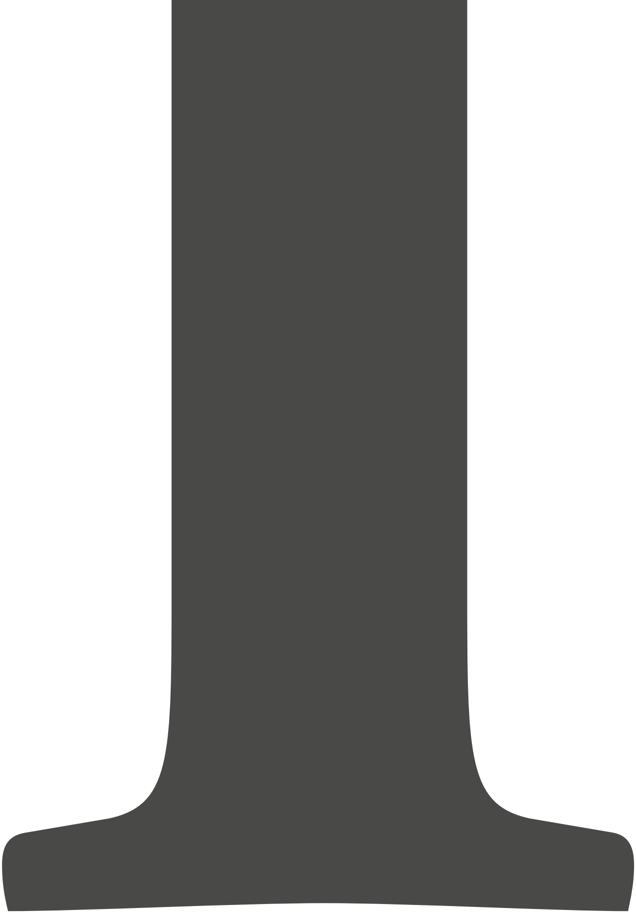


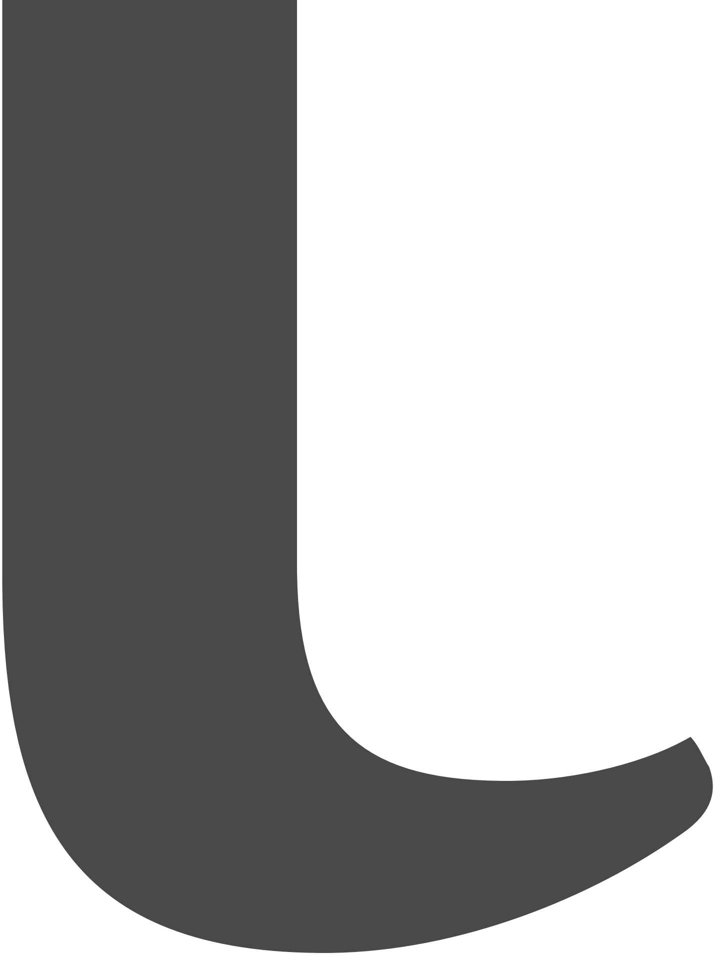
a

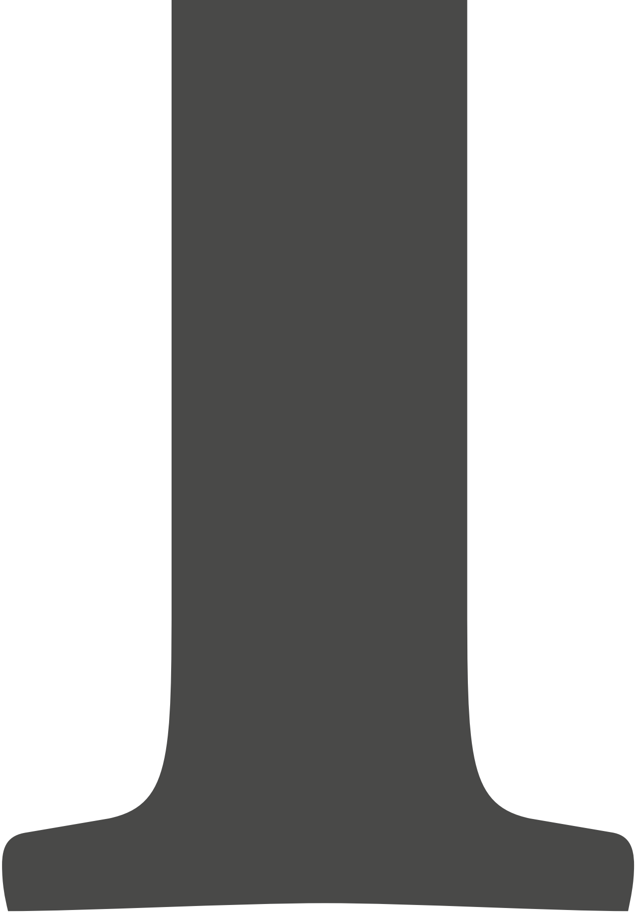


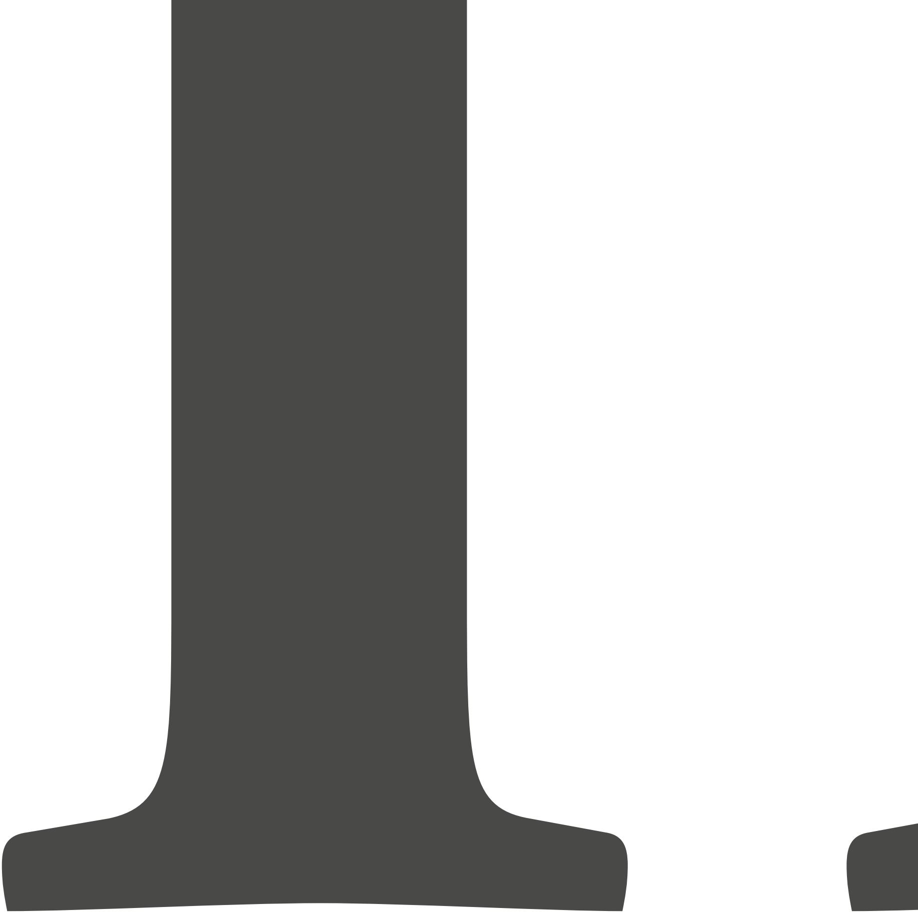


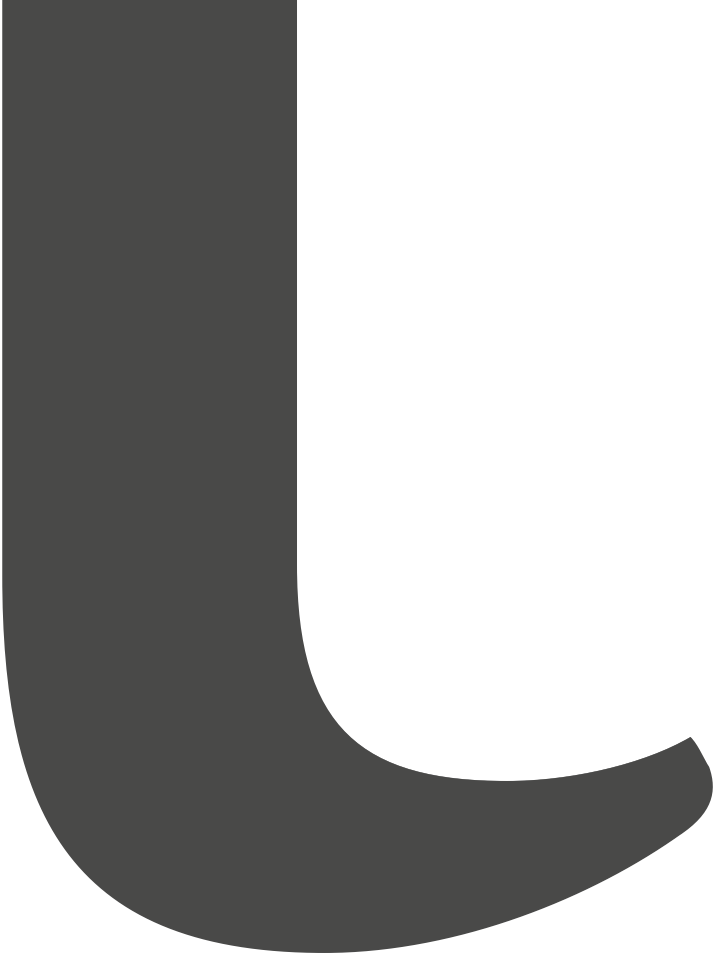


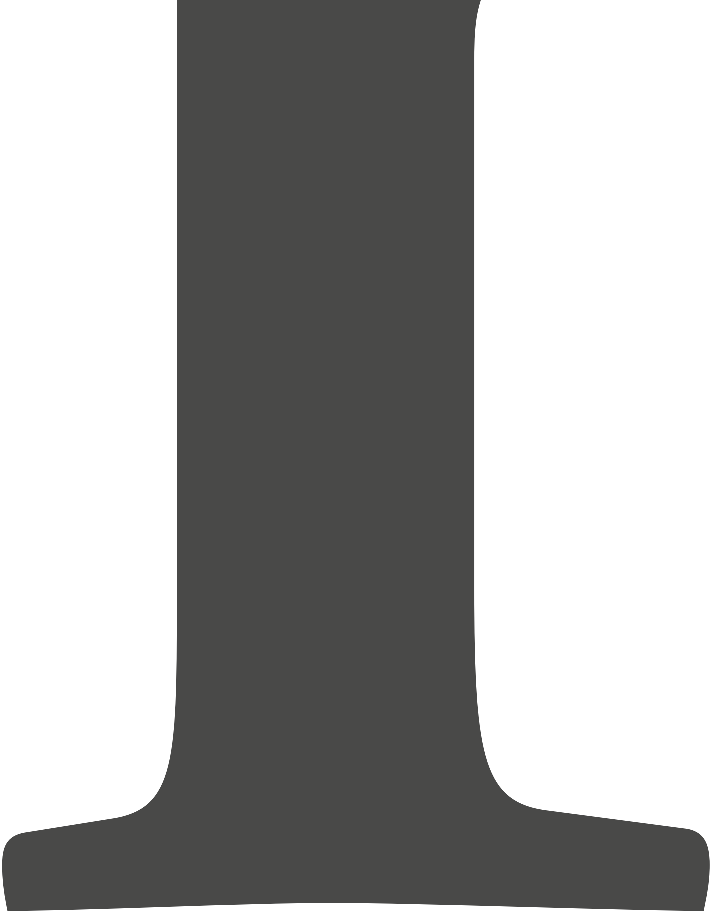




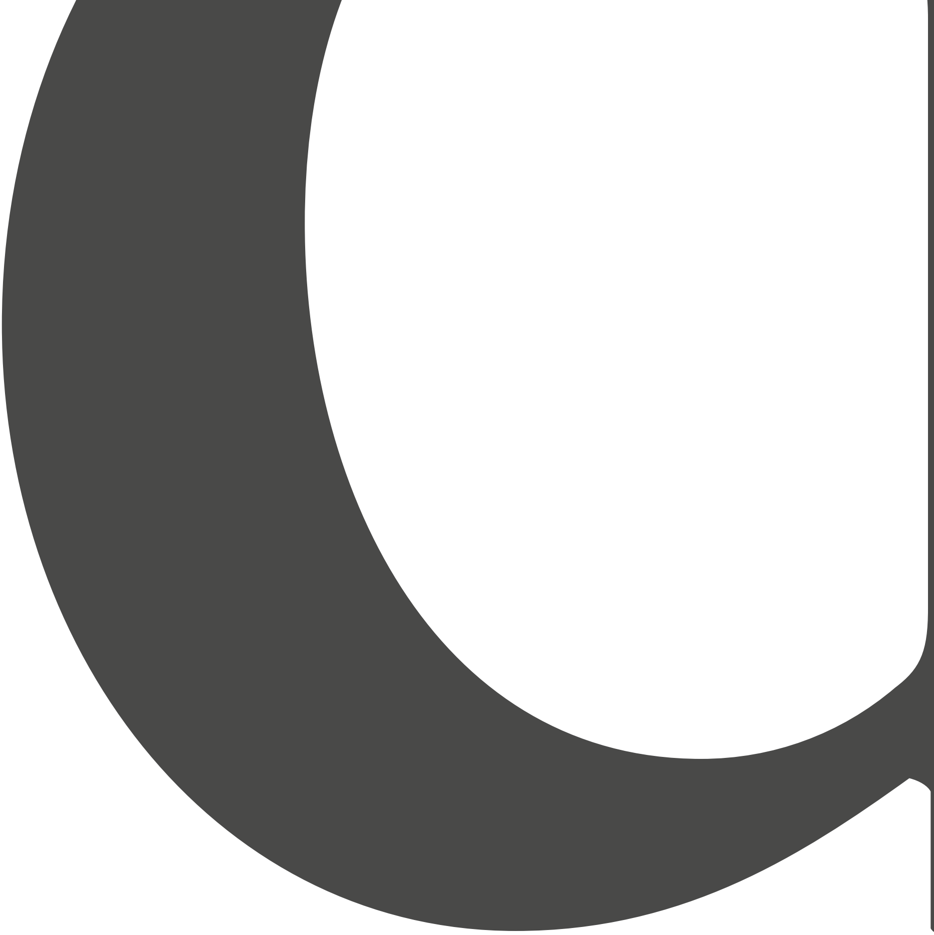


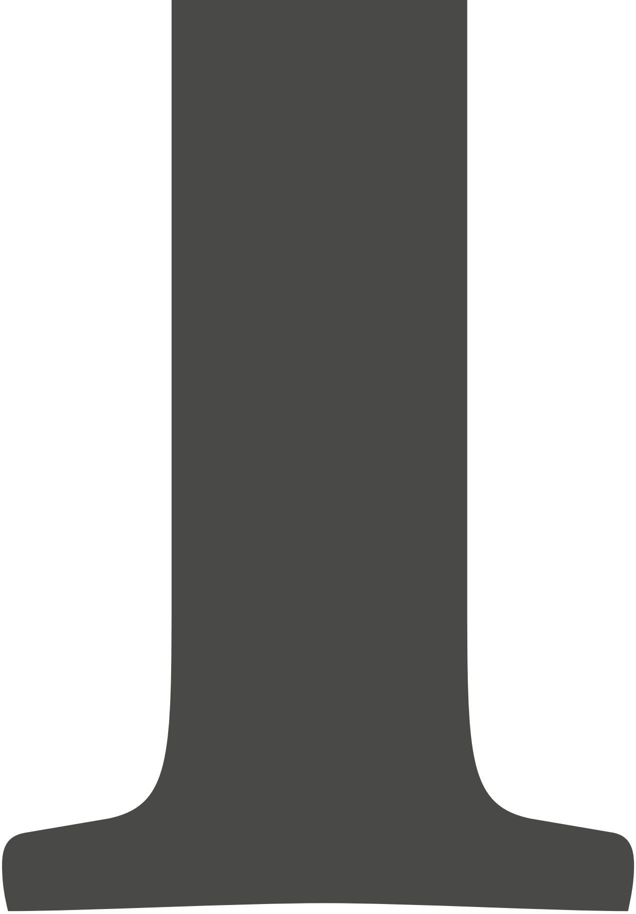


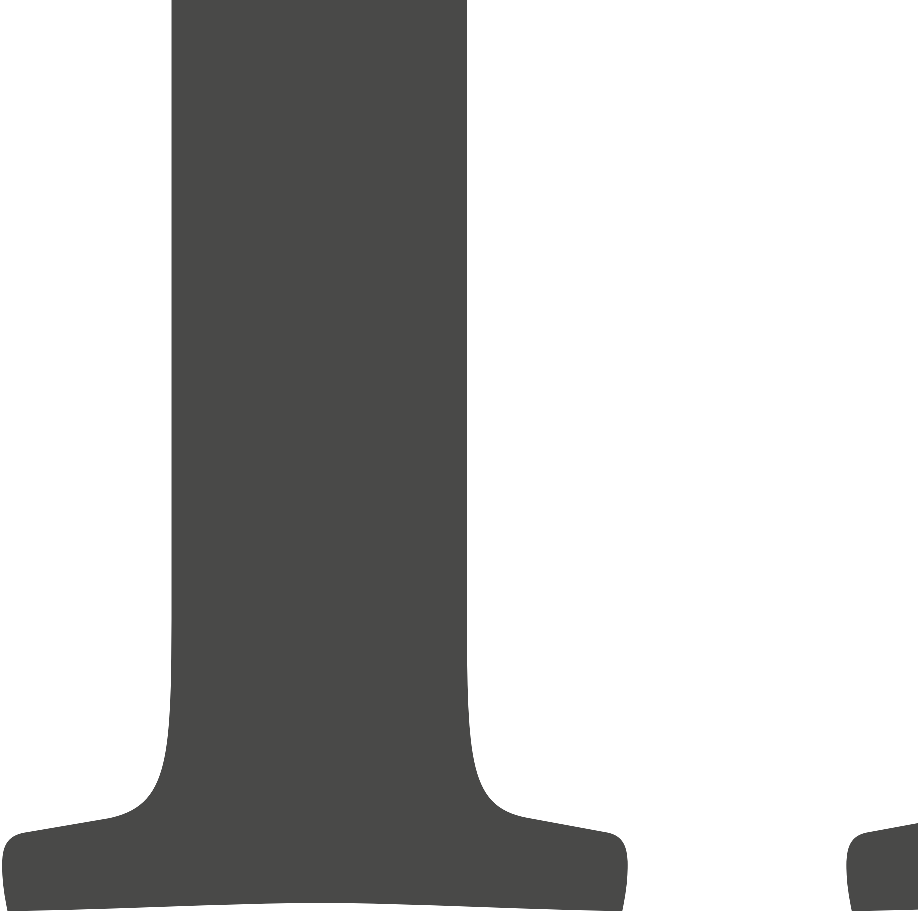


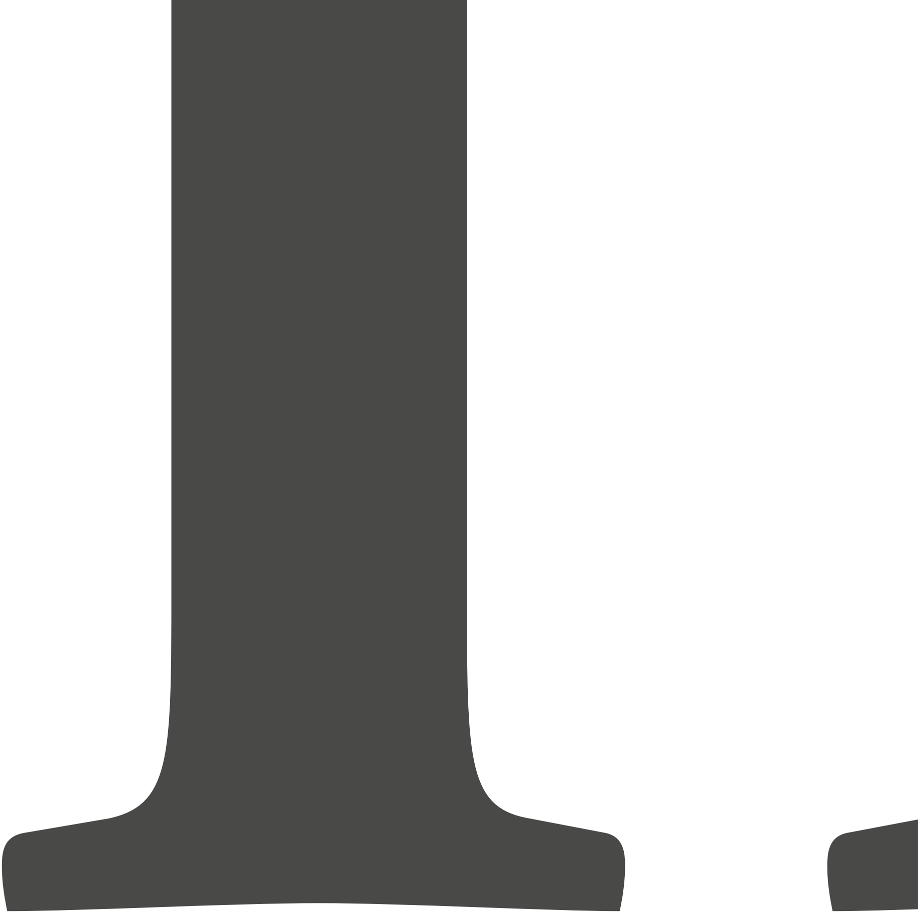


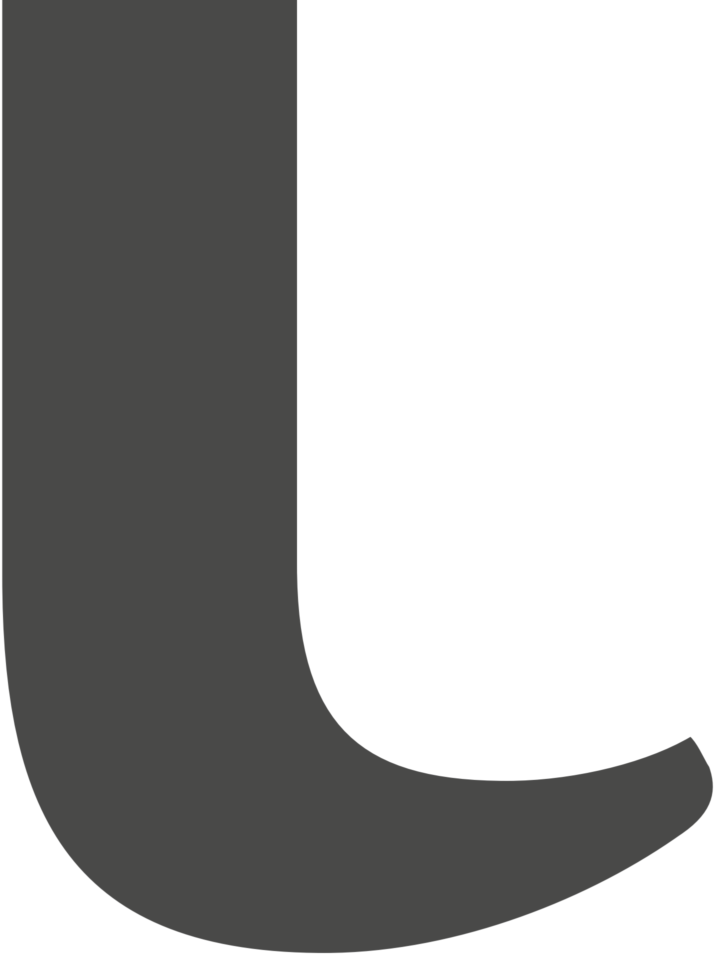
V

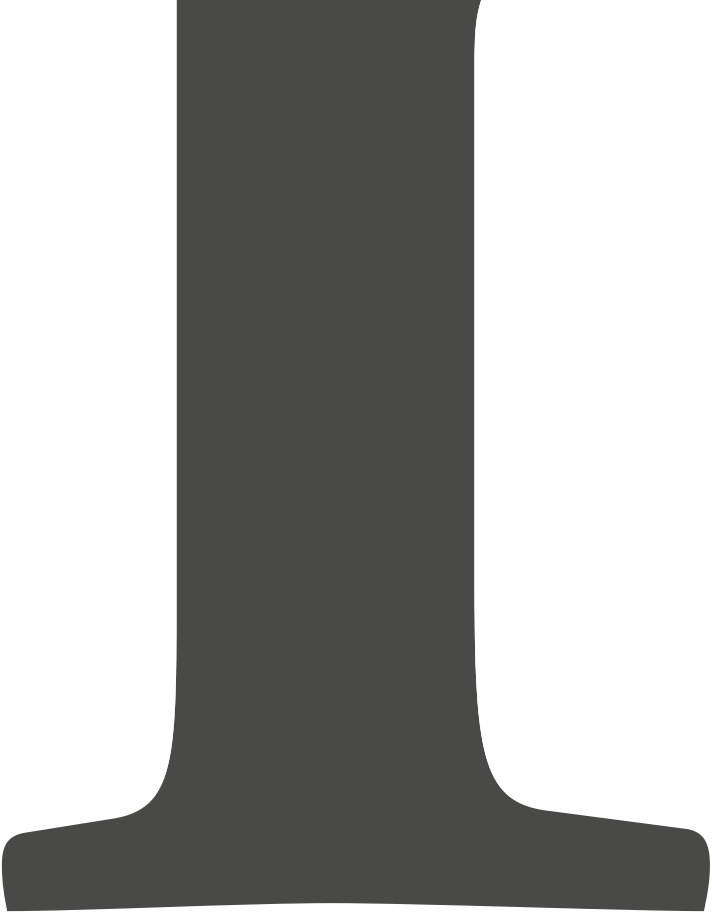


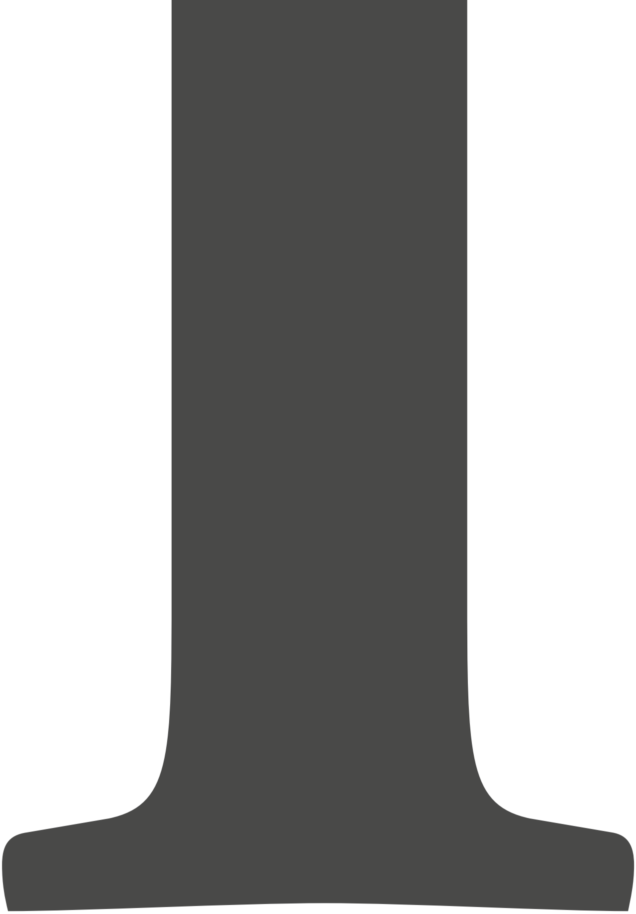


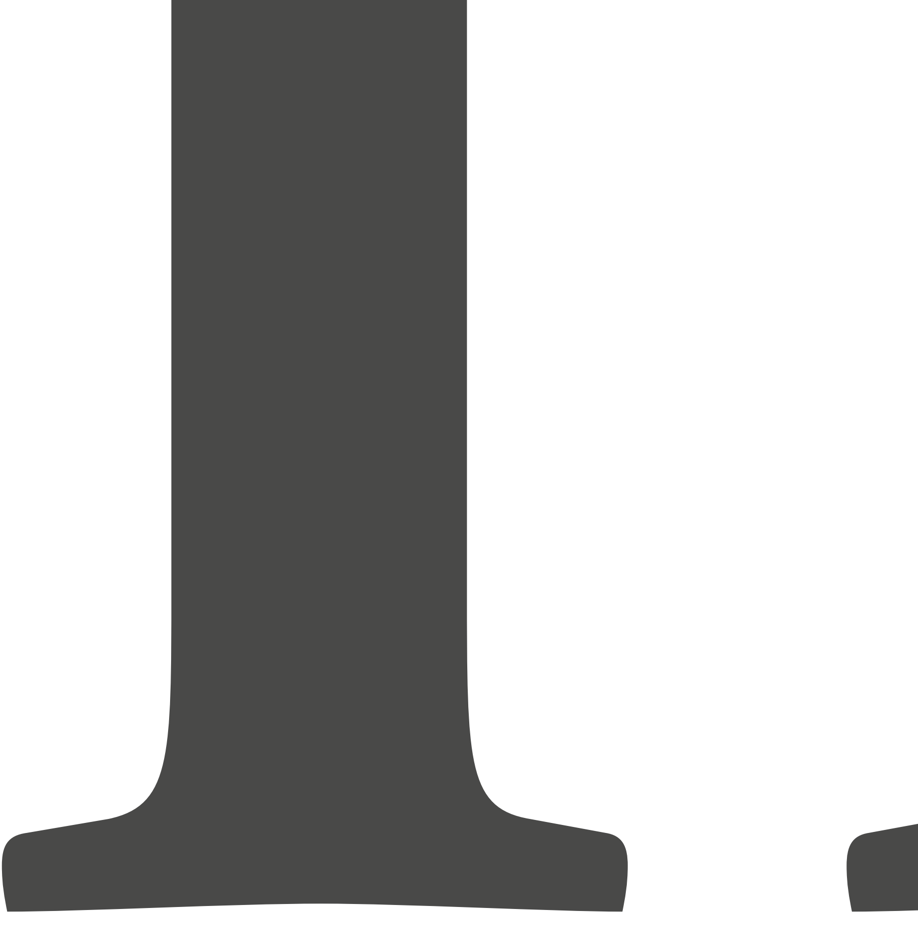


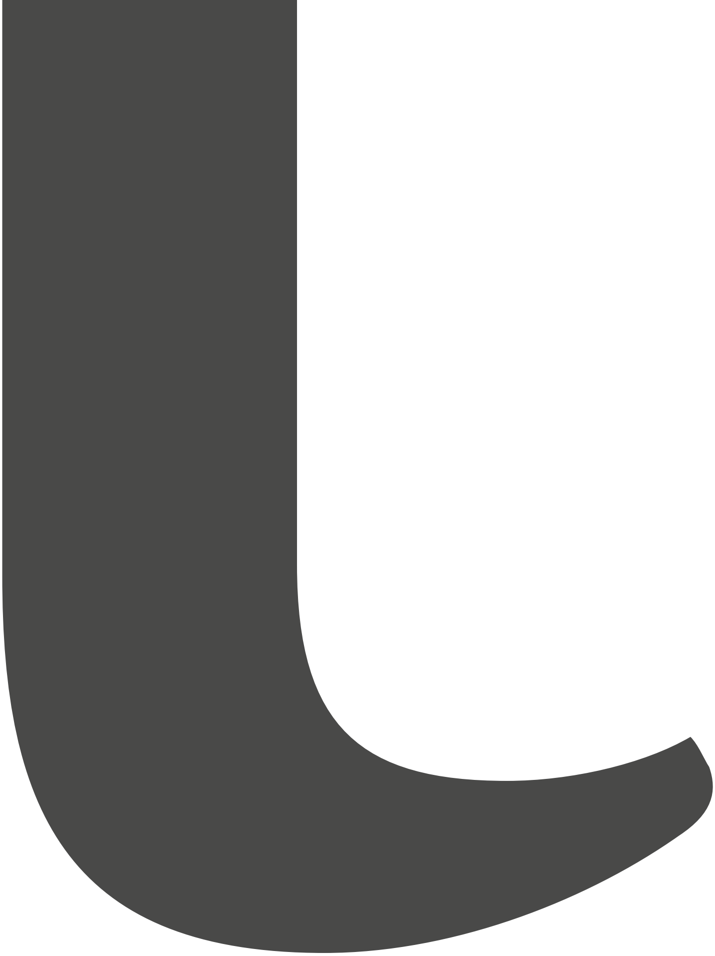


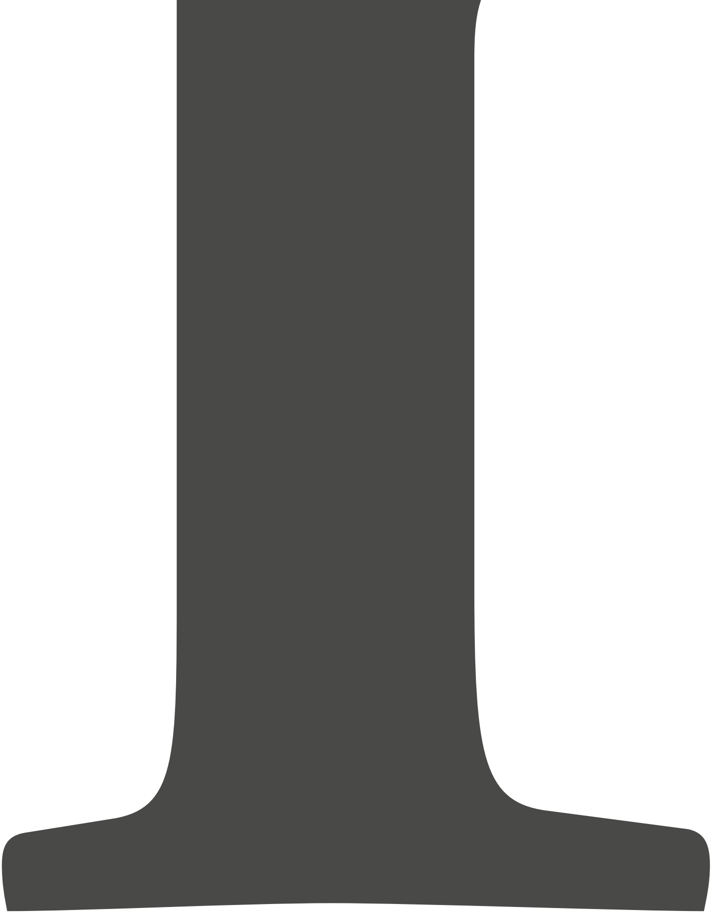


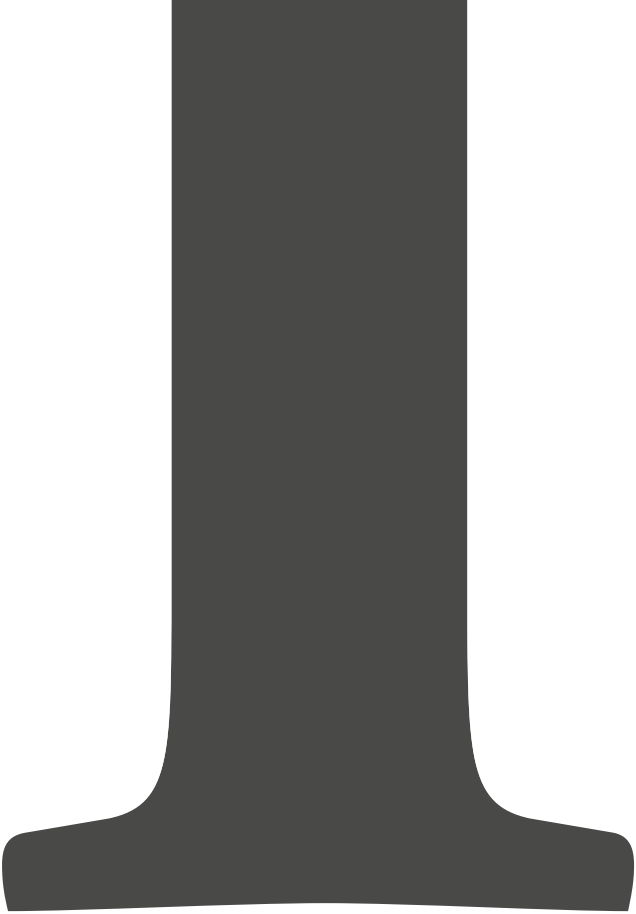


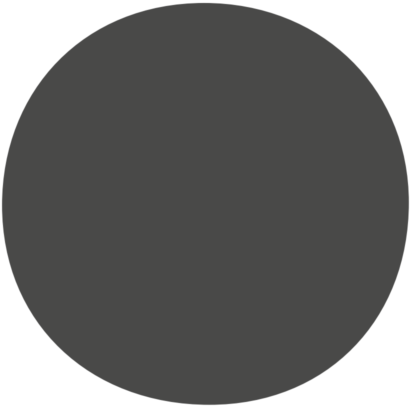




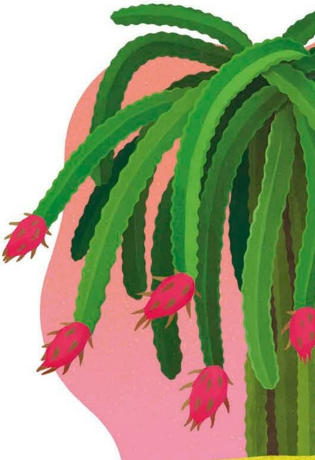




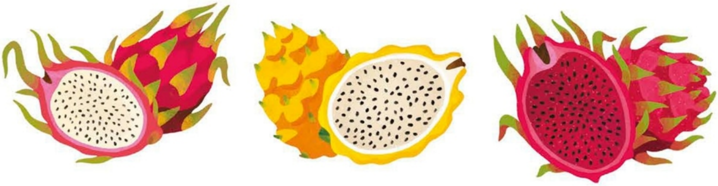




Dragon fruit



White-fles
dragon f
(Selenicereus u
In its Central Am
home, the drag
cactus often grow
on trees. Its long s
from the bran

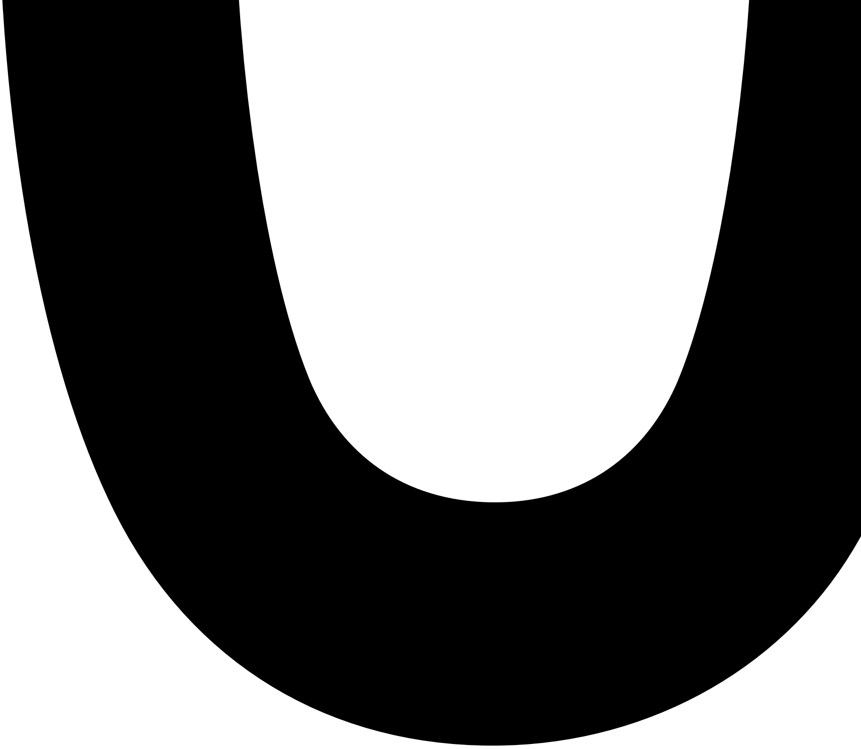


Three of a kind

Most of the dragon fruits we see in shops and food markets have pink skin with white flesh. Two other types exist: one has yellow skin with white flesh, and the other has pink skin with red flesh.

A

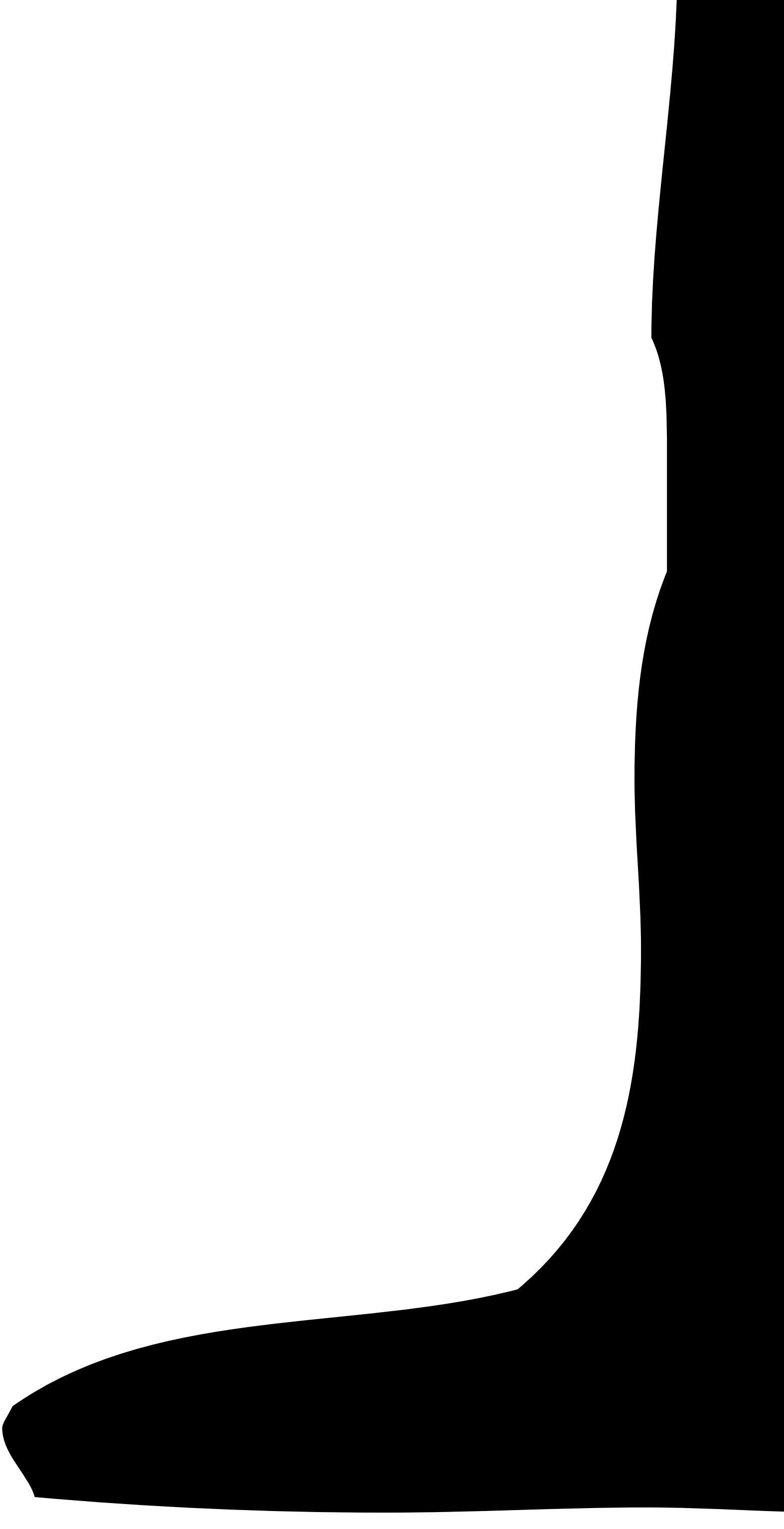
G

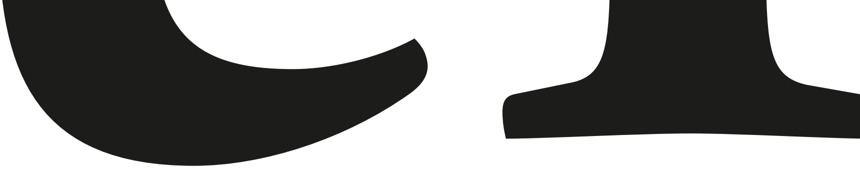


[redacted]

U

[redacted]





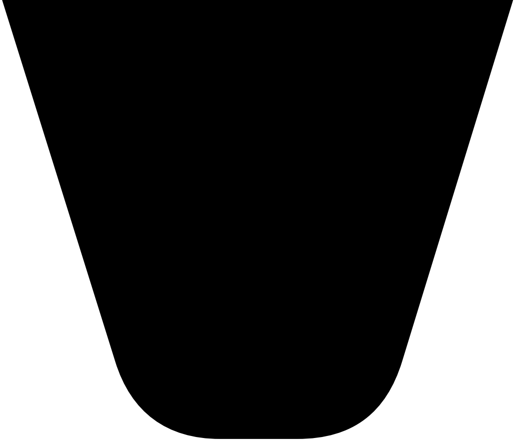
M

f

T

w

w



l

h

C

o

fr

W

d

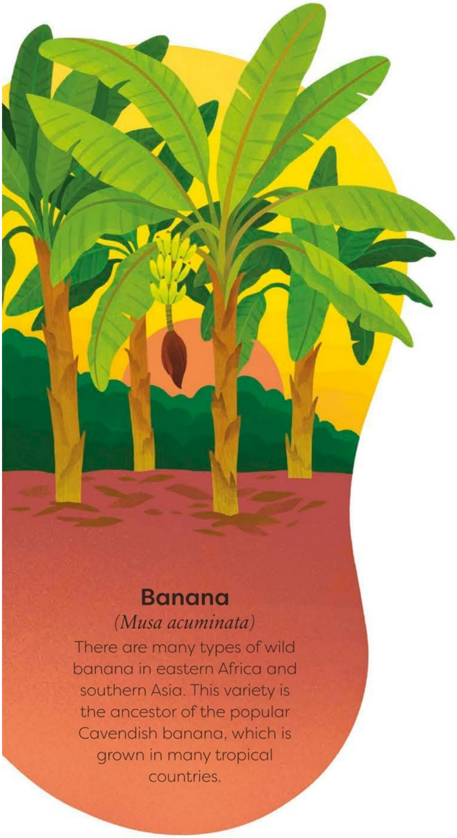
Y

d

R

d

Banana



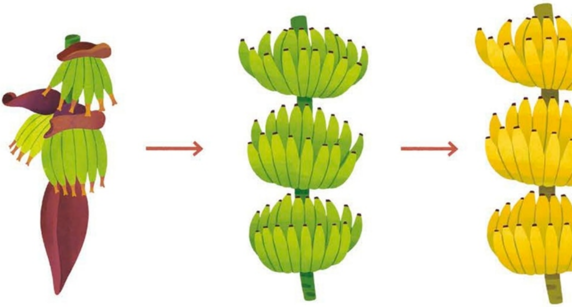
Banana

(Musa acuminata)

There are many types of wild banana in eastern Africa and southern Asia. This variety is the ancestor of the popular Cavendish banana, which is grown in many tropical countries.

How bananas grow

Banana flowers are small tubes which hang from the plant in rows. They develop into bunches of fruit, known as hands, that start out green and pointing down toward the ground. The bananas take three to six months to mature into full-size yellow fruit, turning up toward the Sun as they ripen.



B

w

T

k

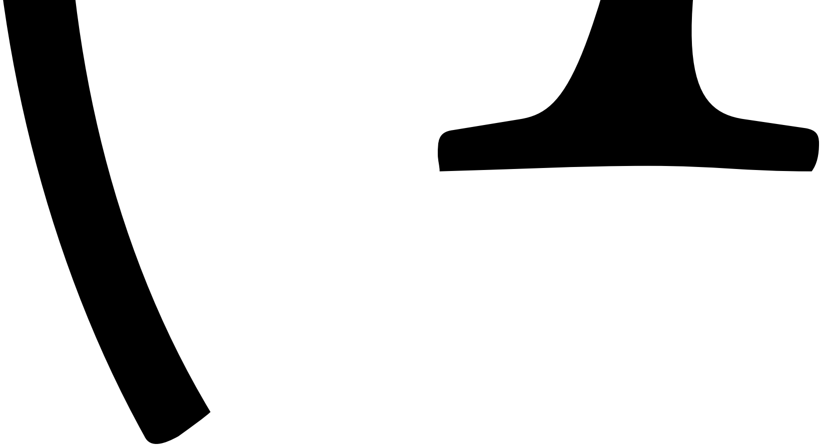
g

th

th

fu

t



T

b

S

th

C

g

C

F

d

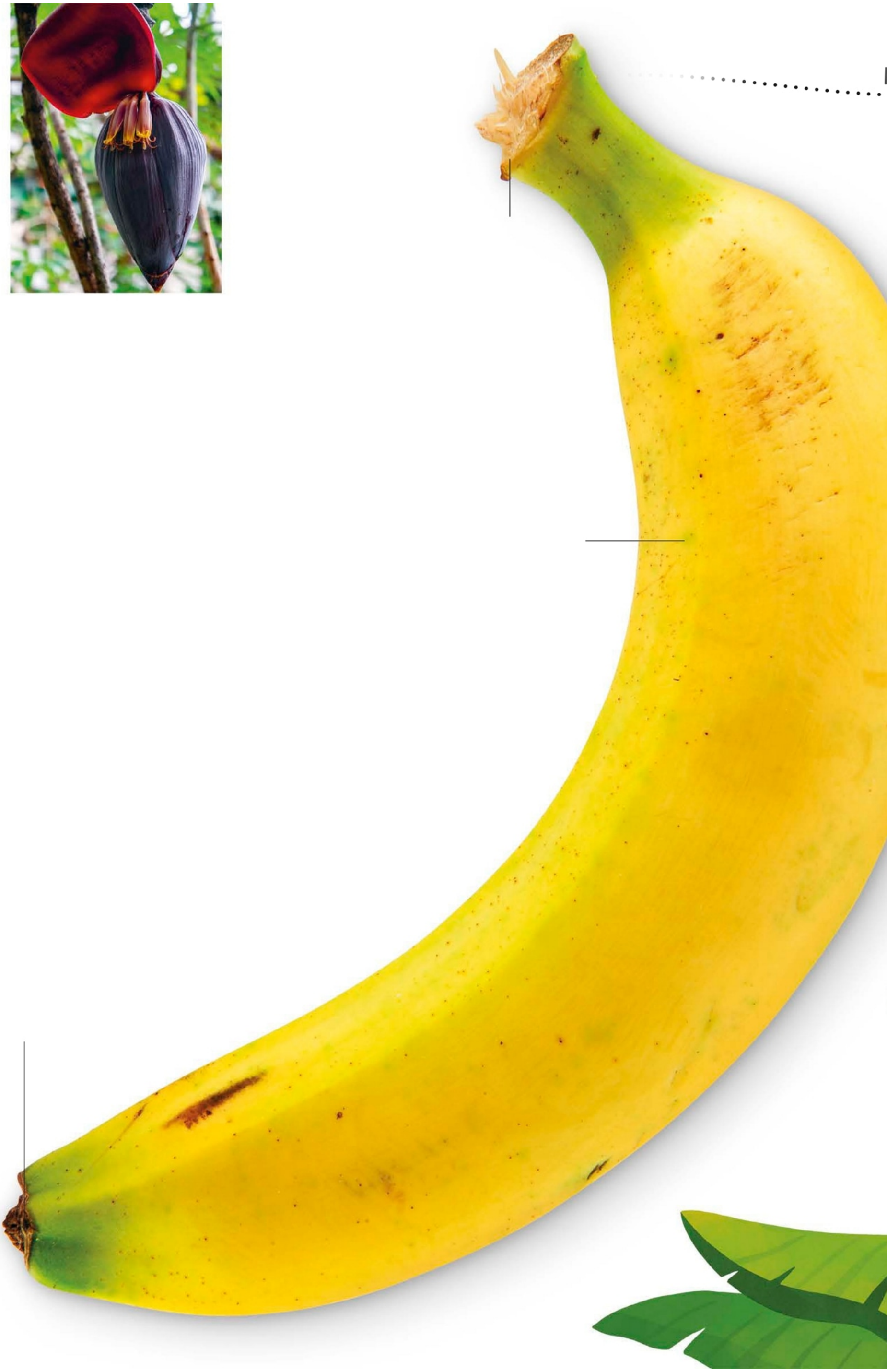
in

G

ri

R

fr



B

p

C

g

W

C

B

fr

W

10

B

e

th

t

W

U

h

C

A

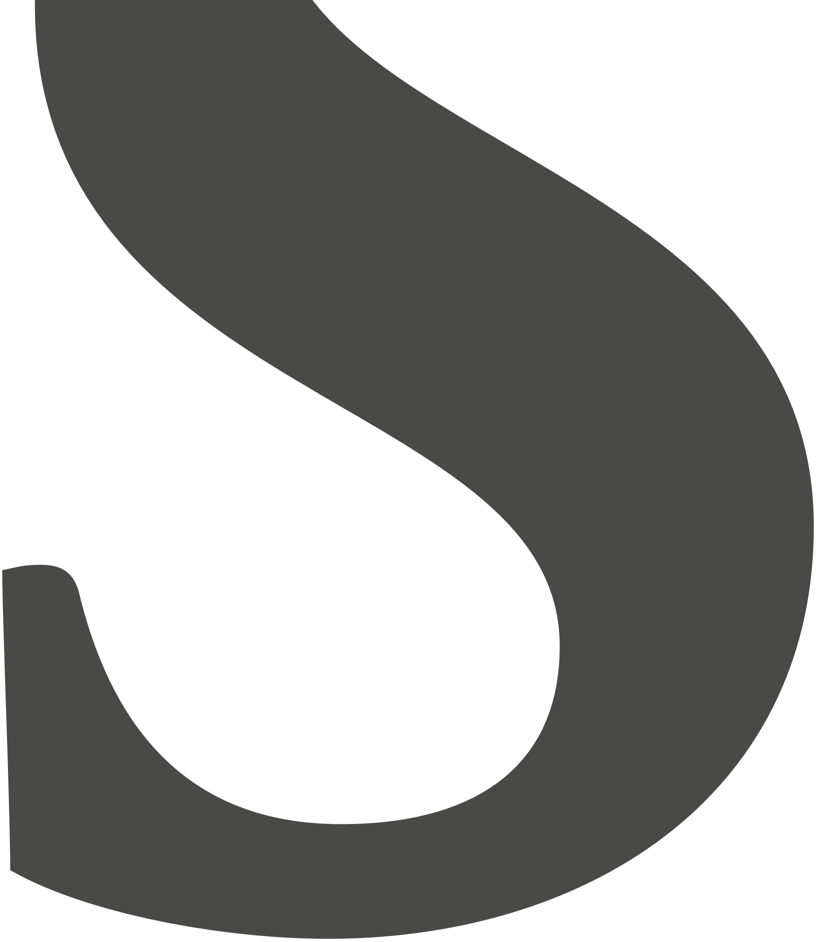
b

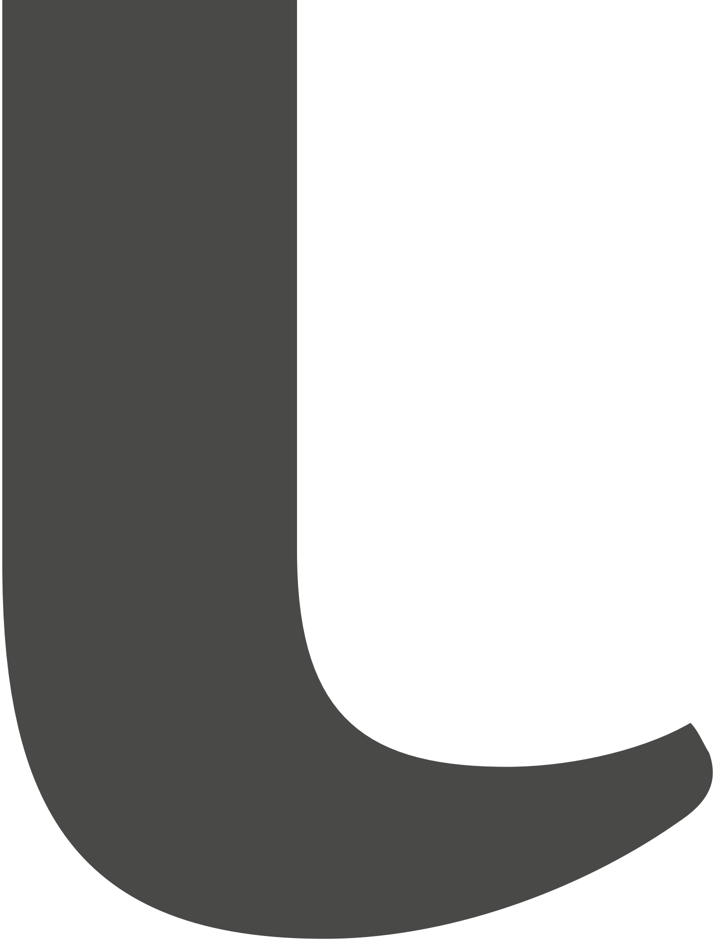
sk

T

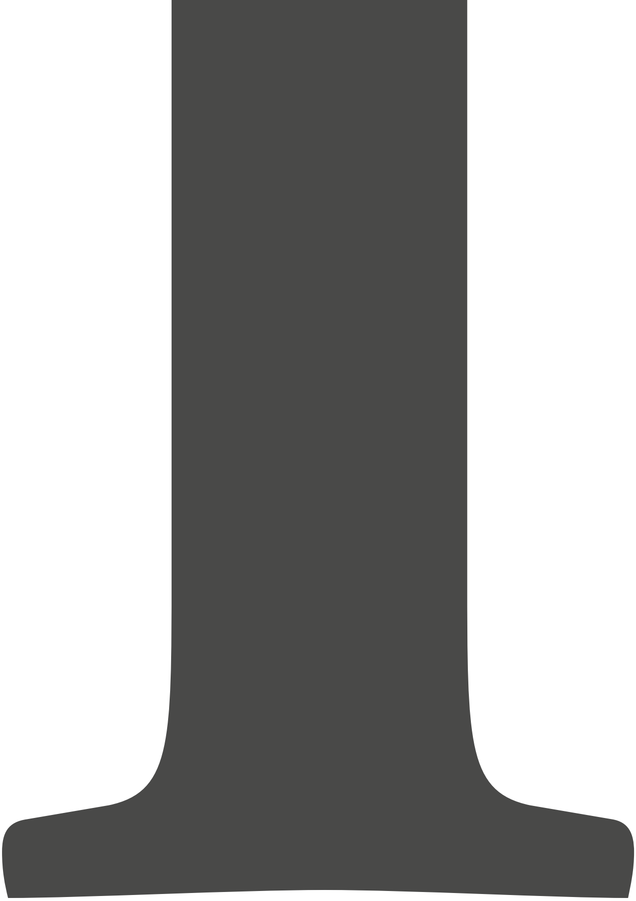
b

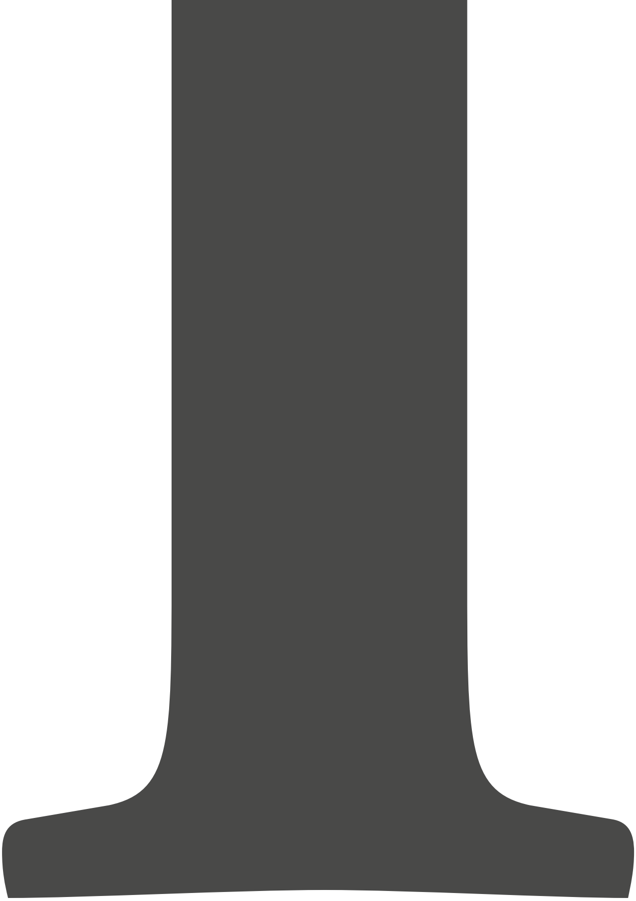
fl

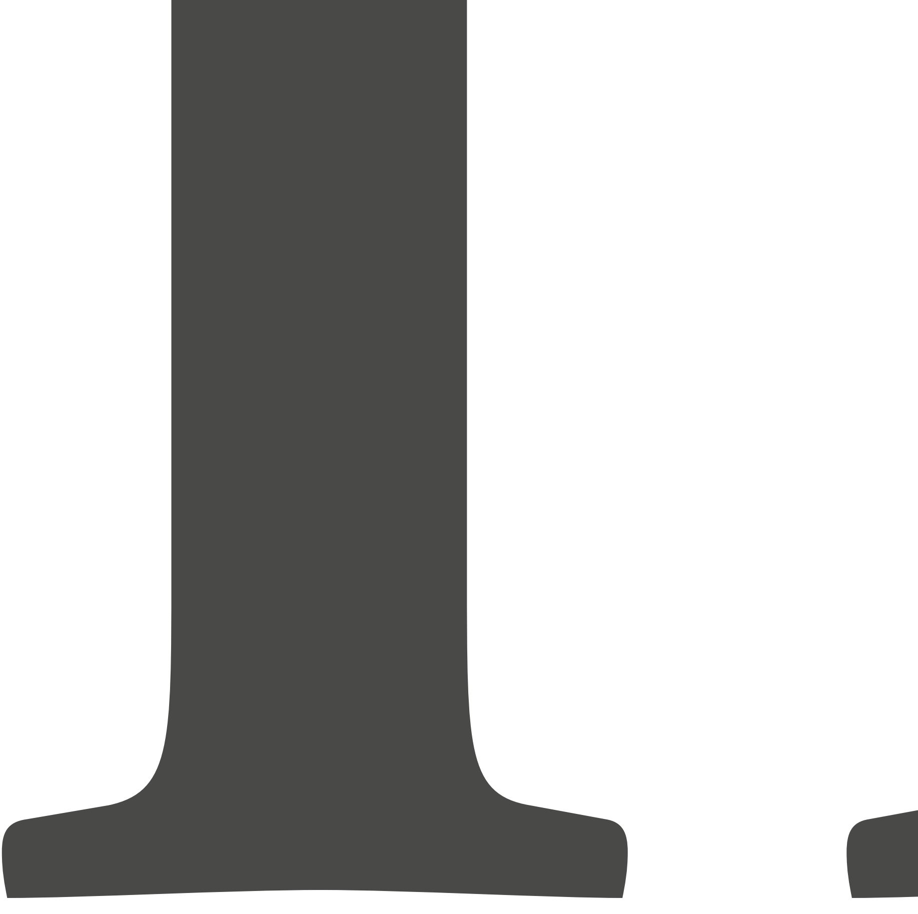




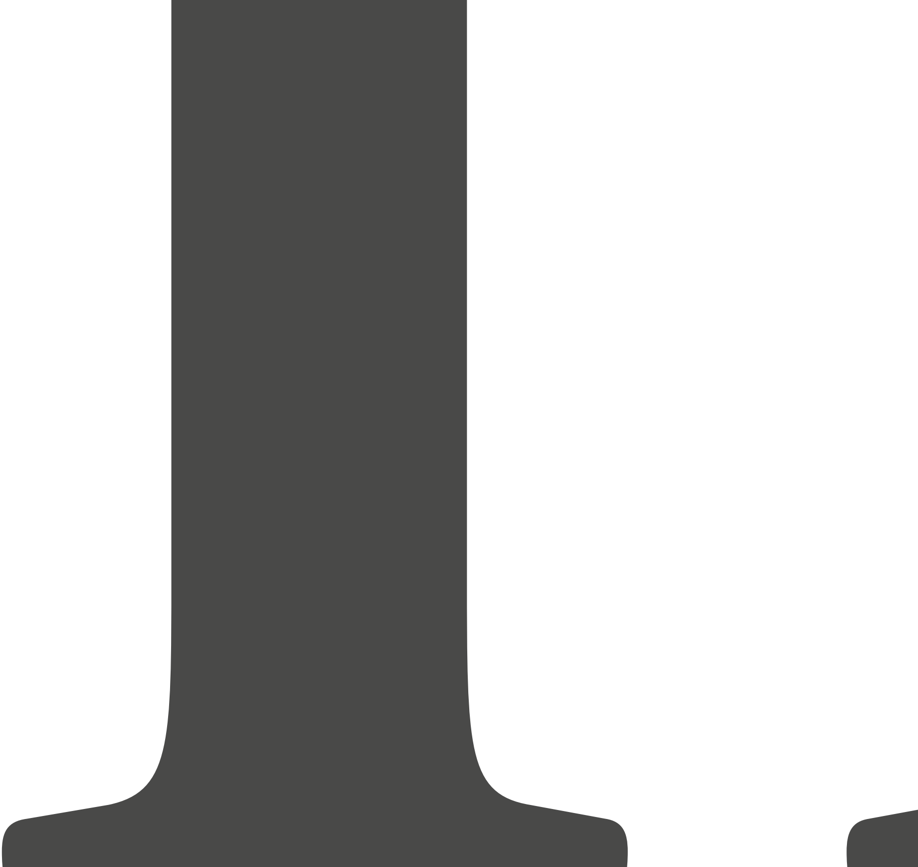
V

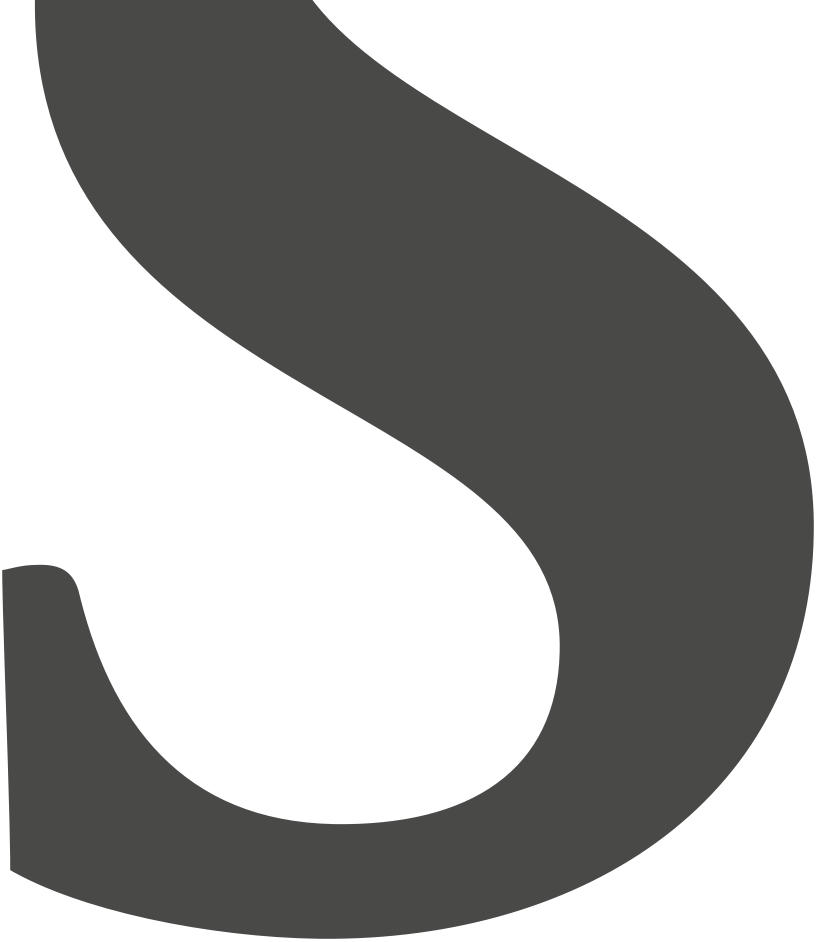


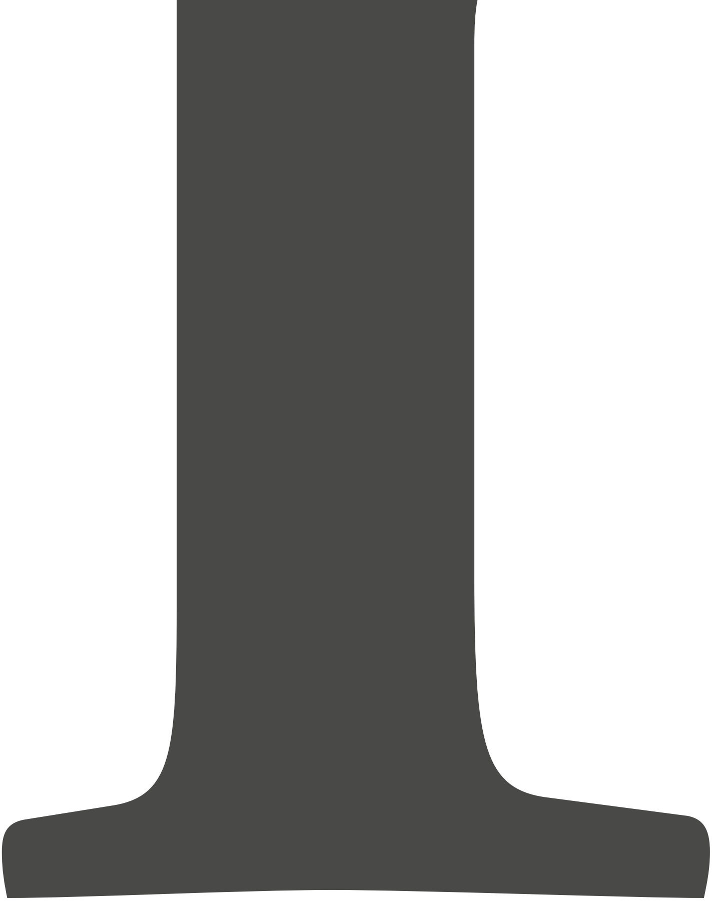




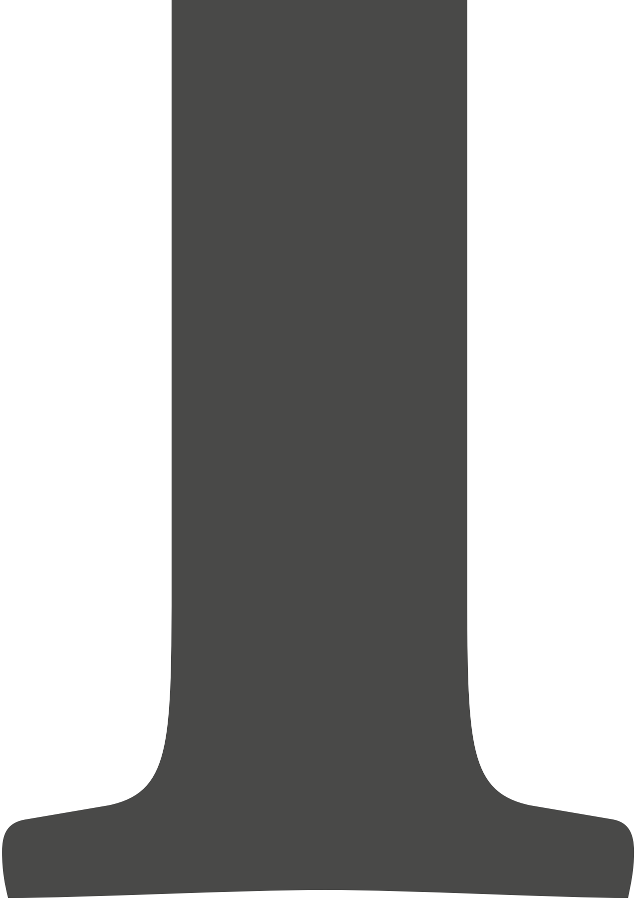
a

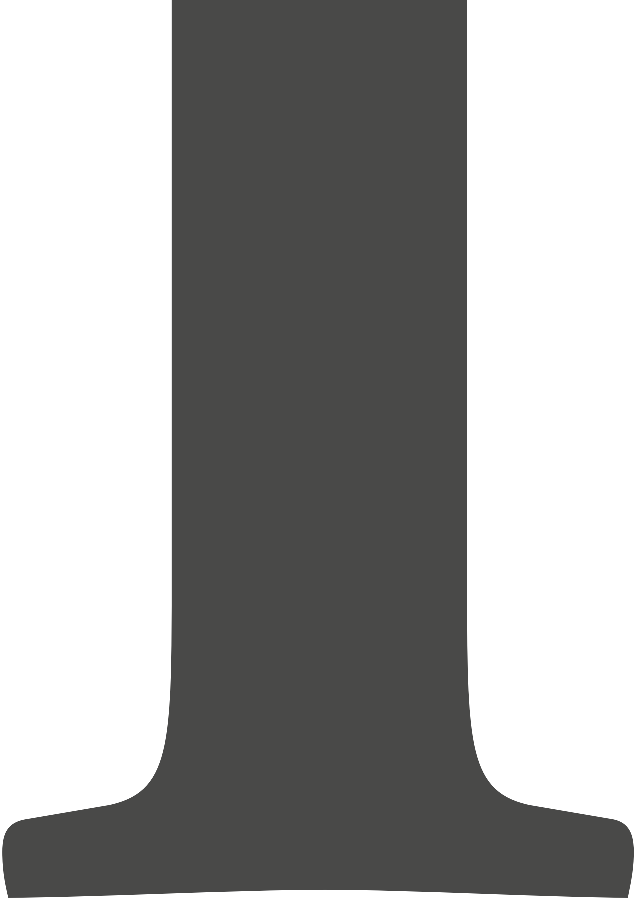


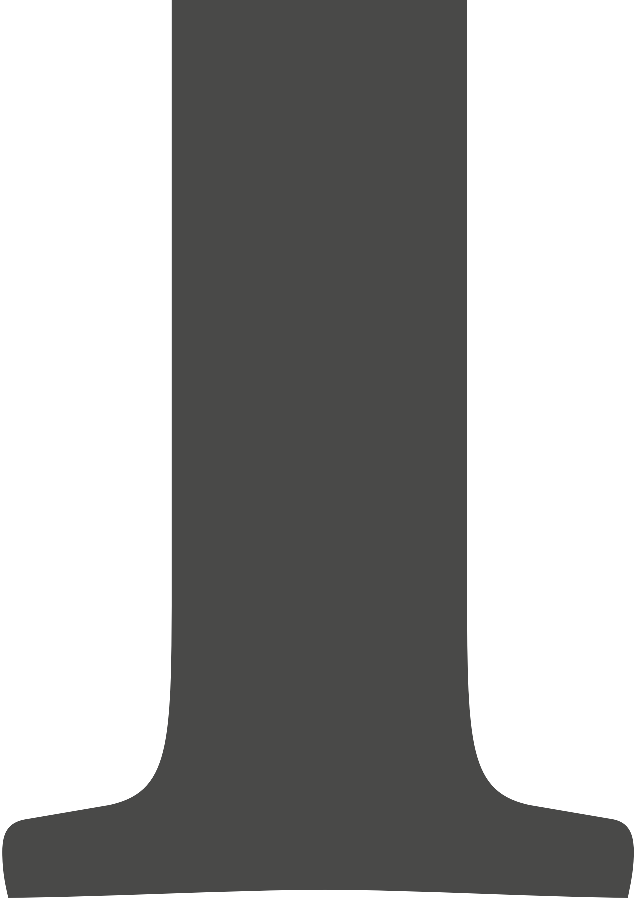


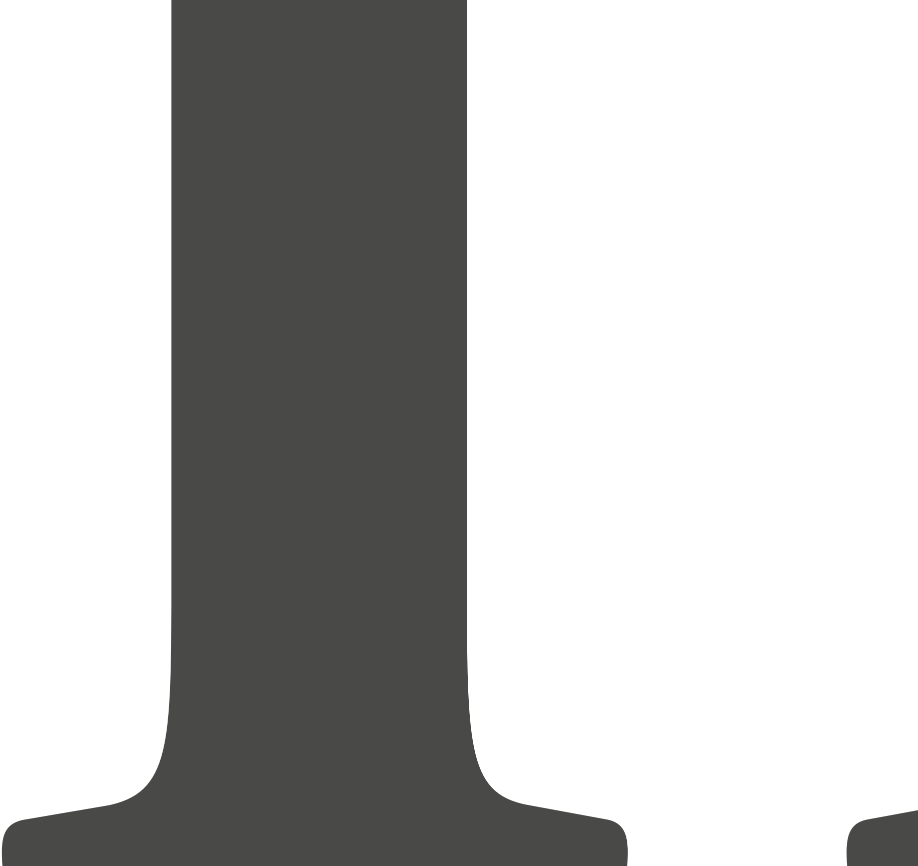


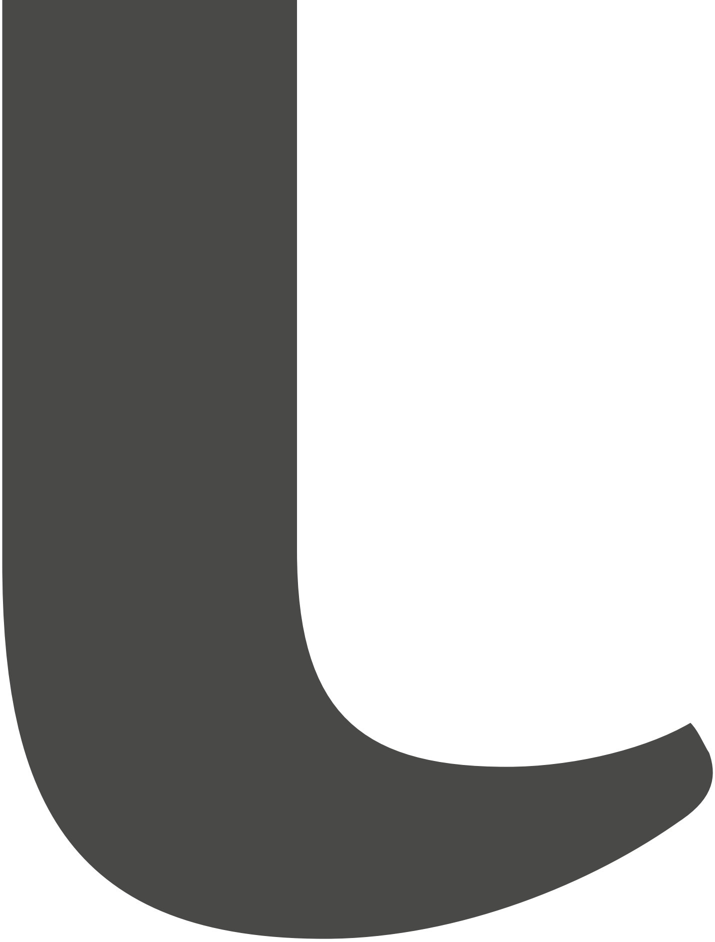
p

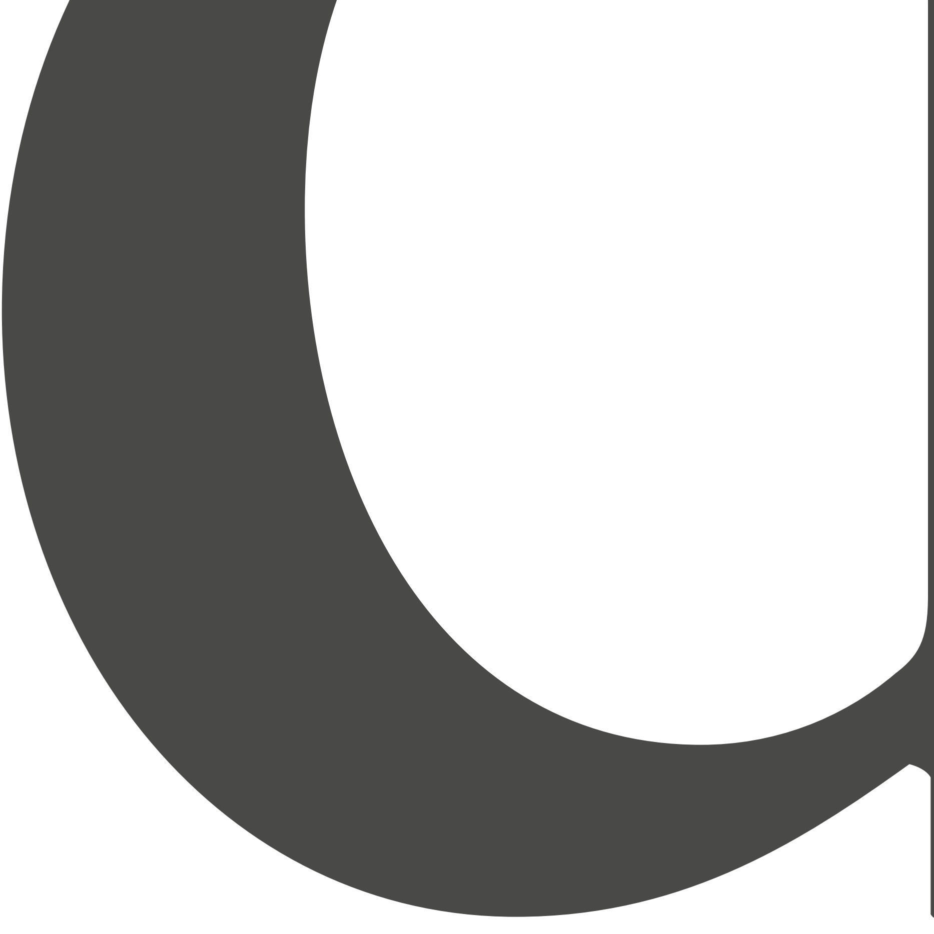




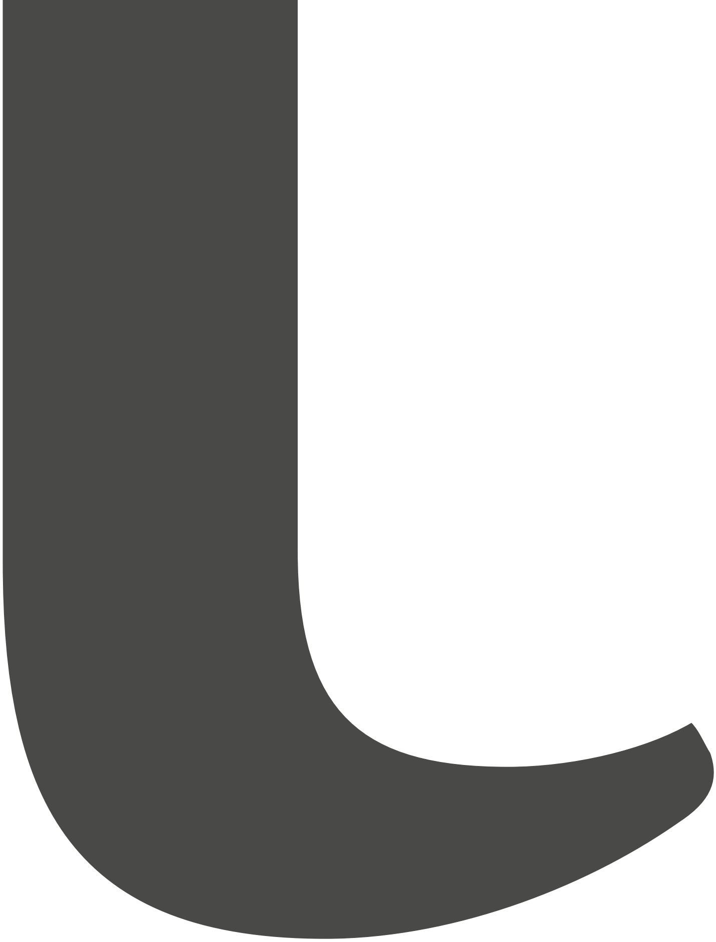


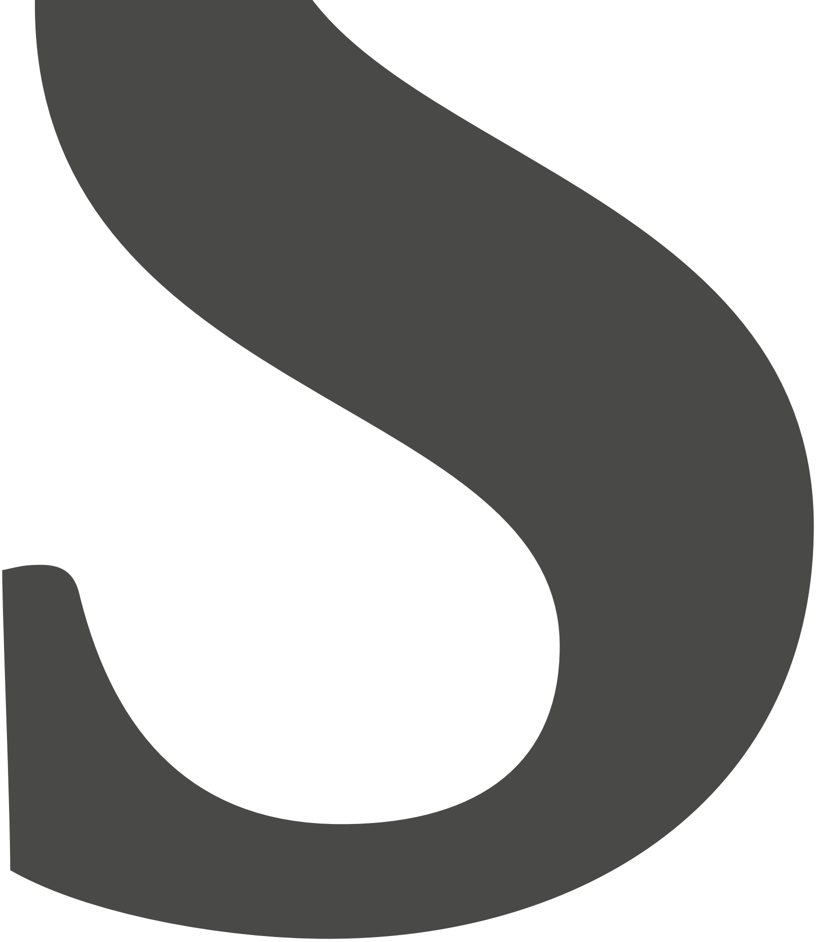


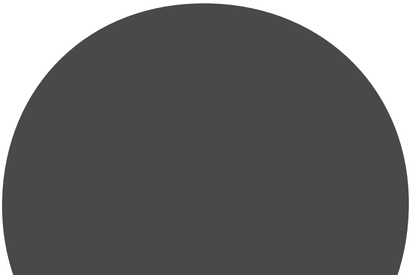




y

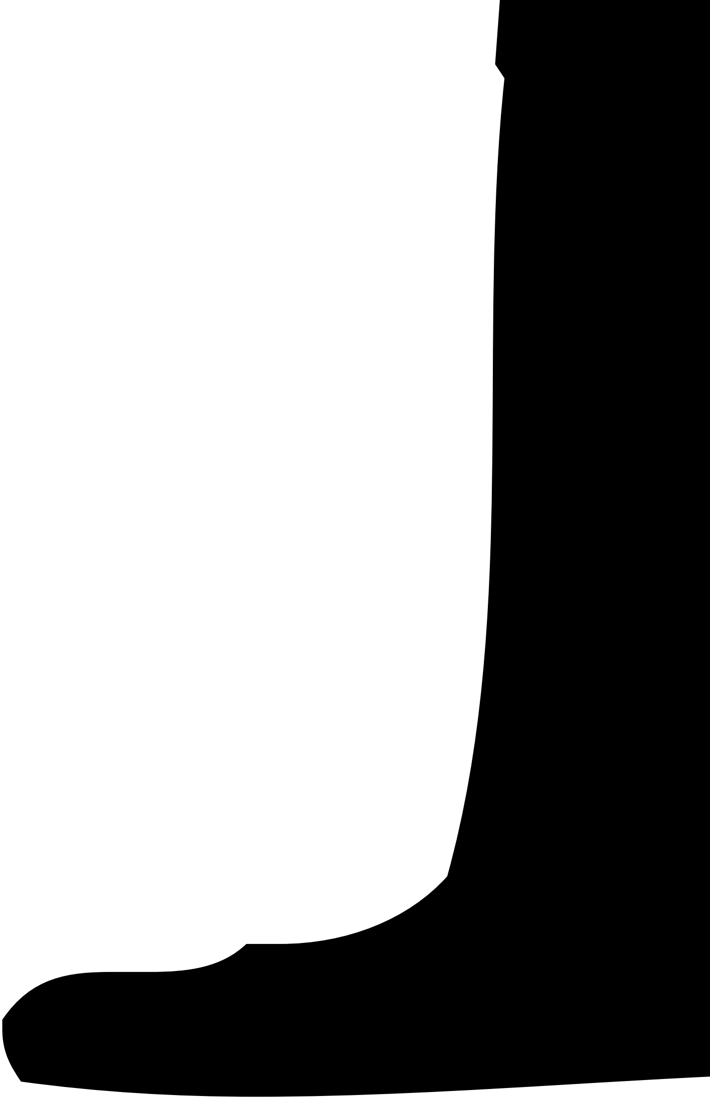


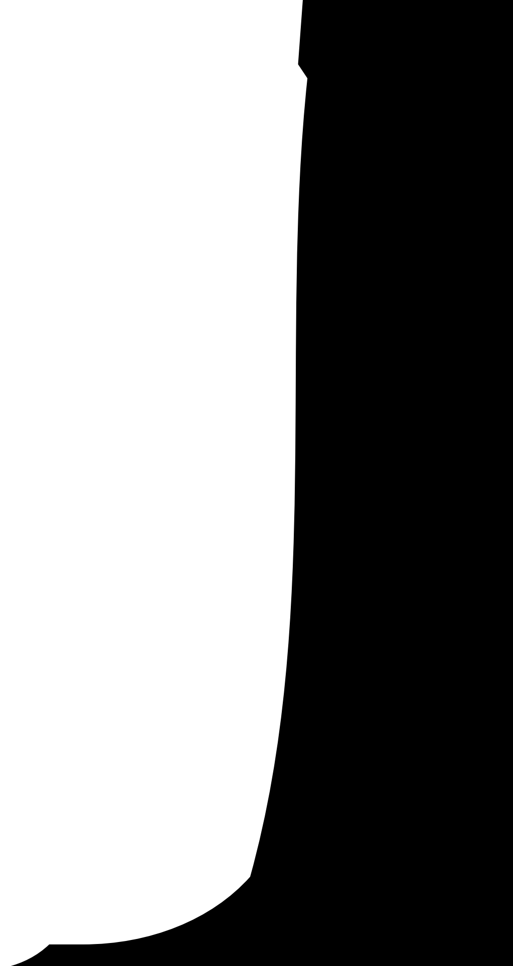


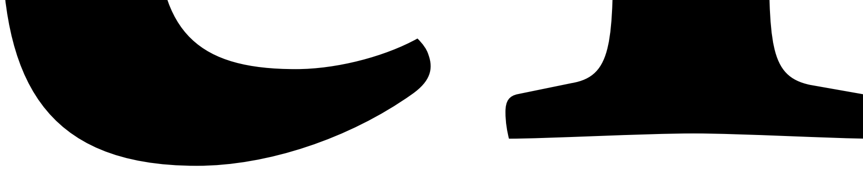


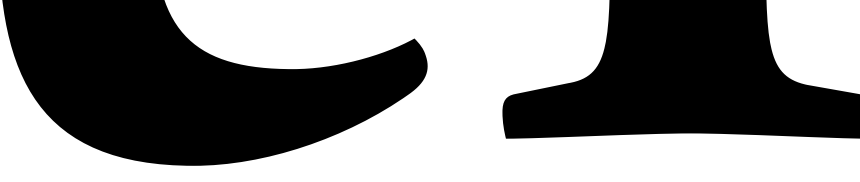
Forest feast

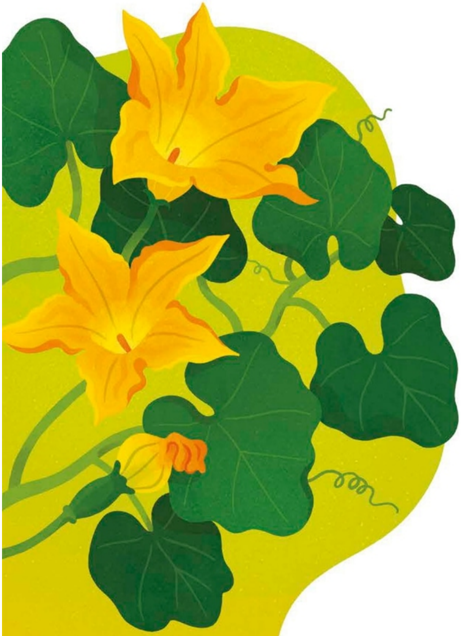
Rain forests have thousands of different trees and vines, which bear fruit at different times. Fruit-eaters, such as this rhinoceros hornbill from southeastern Asia, can always find a fresh supply of ripe fruit somewhere in the forest. As they travel through the treetops, they scatter the seeds in their droppings.



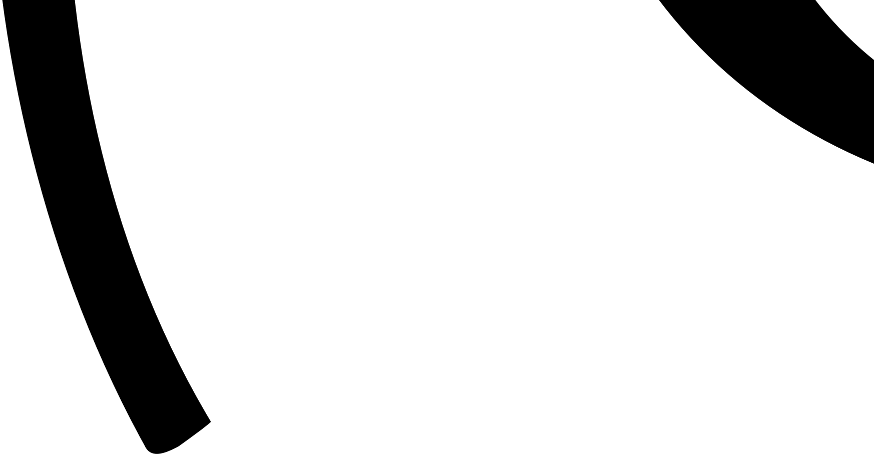








Pumpkin
(Cucurbita pepo)
Pumpkins are grown on most continents. Originally, like most other squashes, they came from Central America and the western half of South America.



P

m

lik

th

A

h

T

st

fr

P

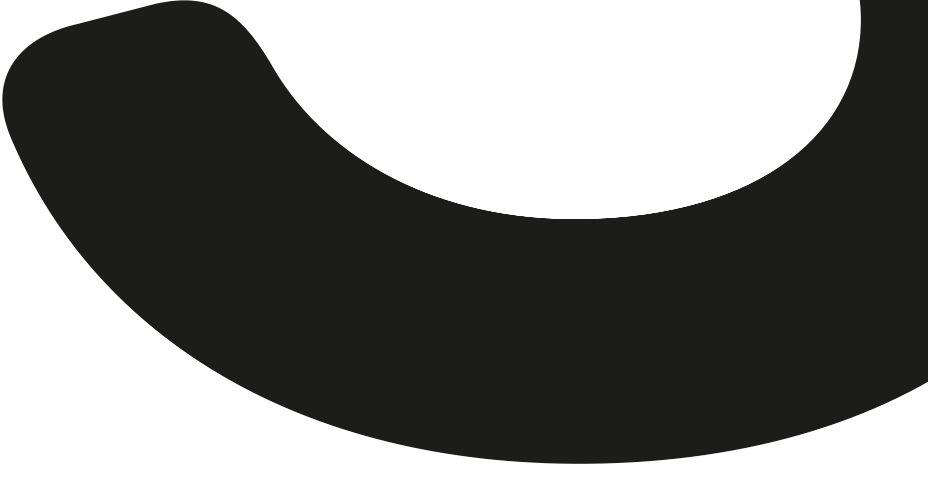
H

th

fl

t

C



P

p

C

fe

n

d

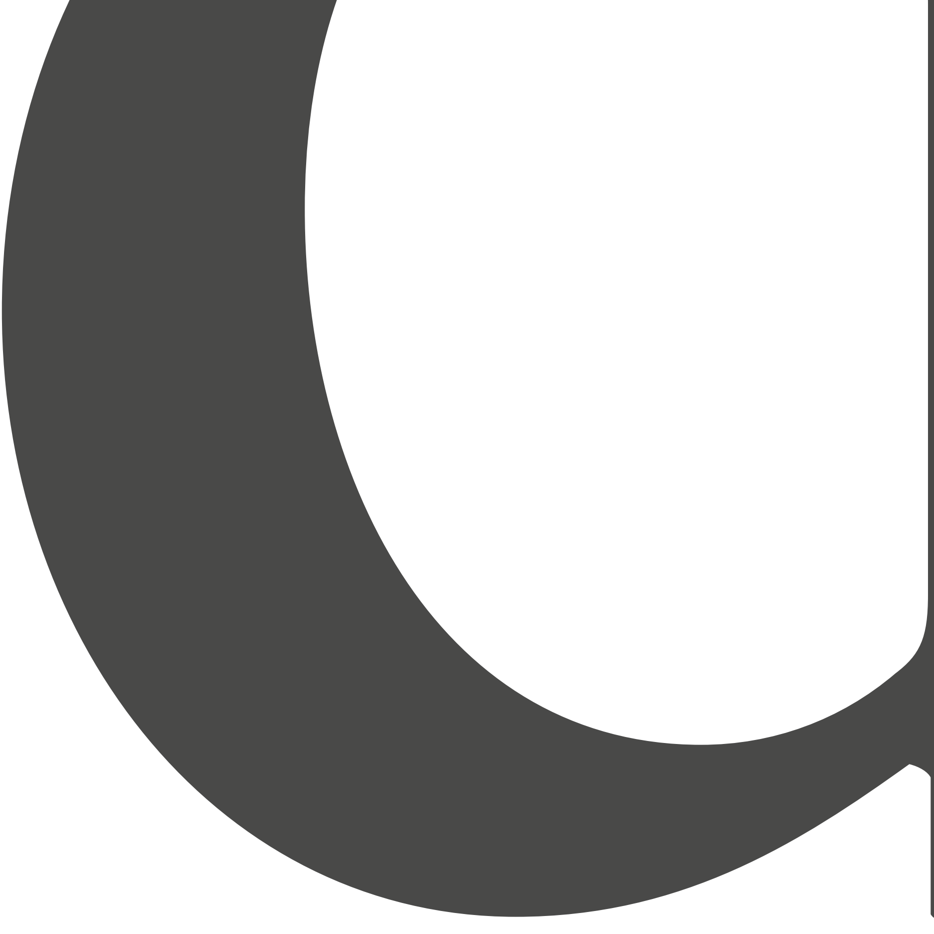
A

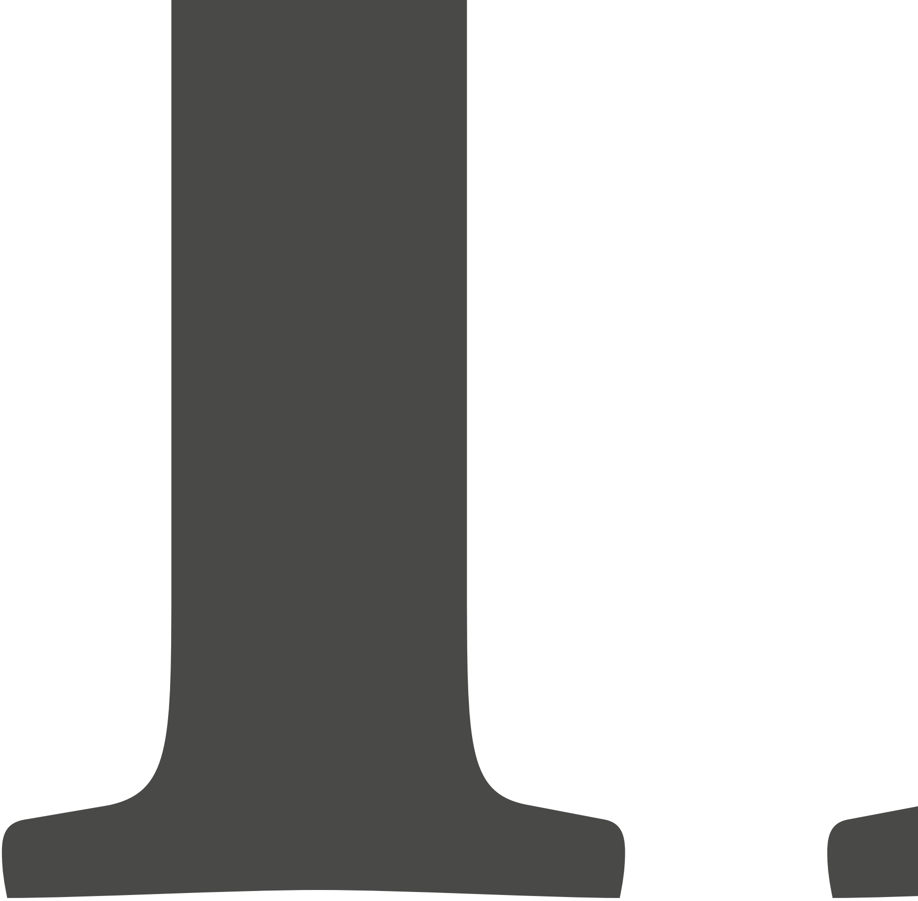
O

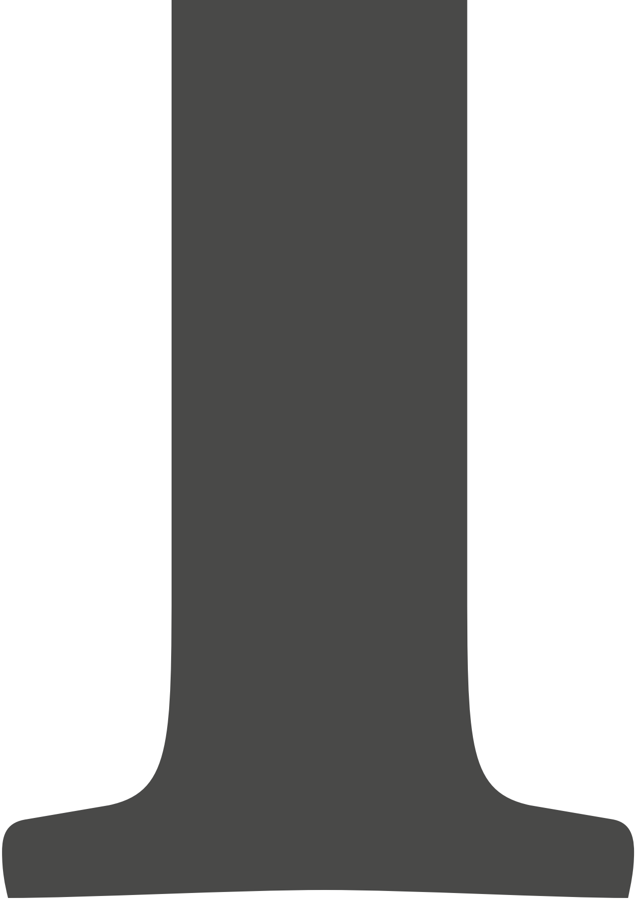
g

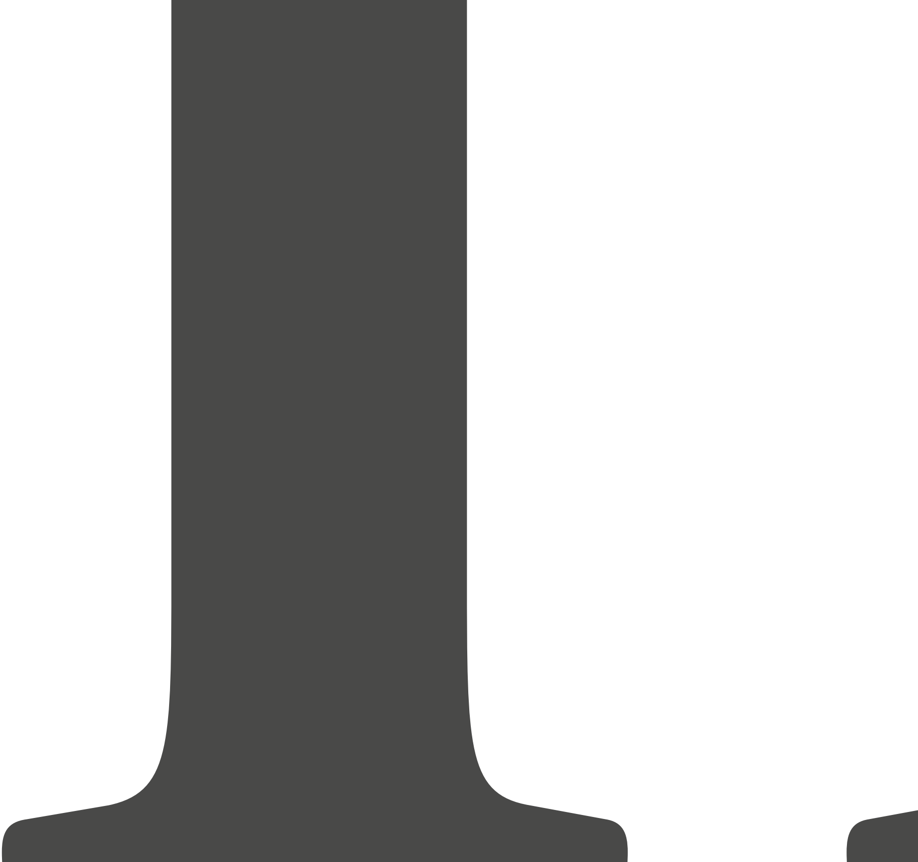
1

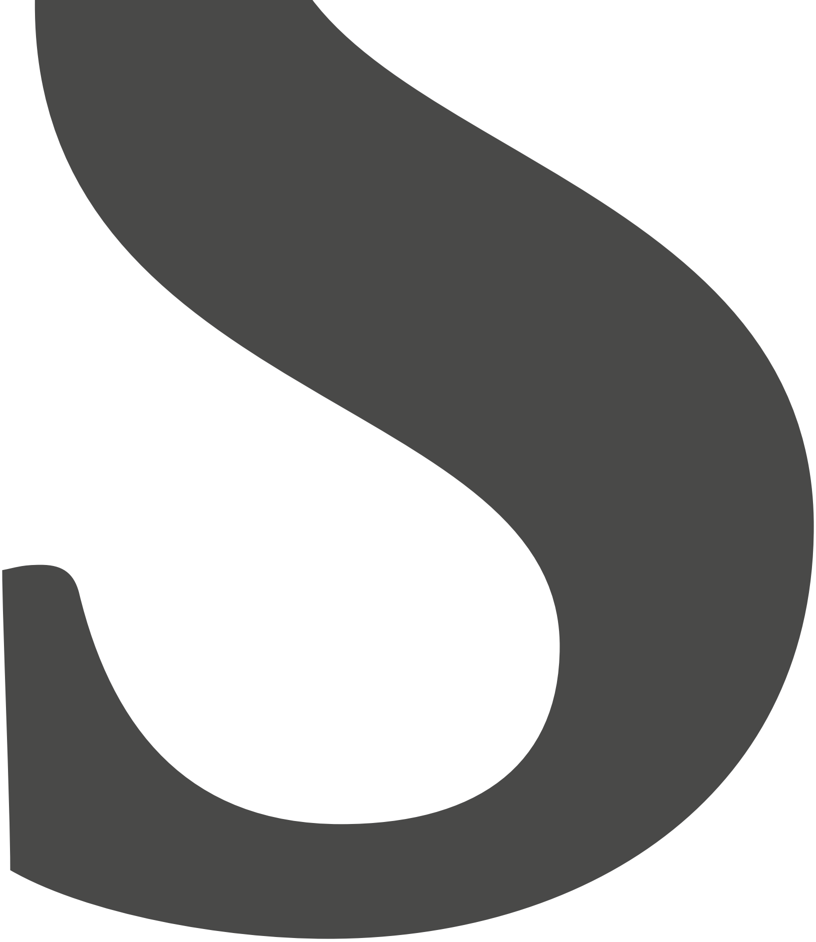
V







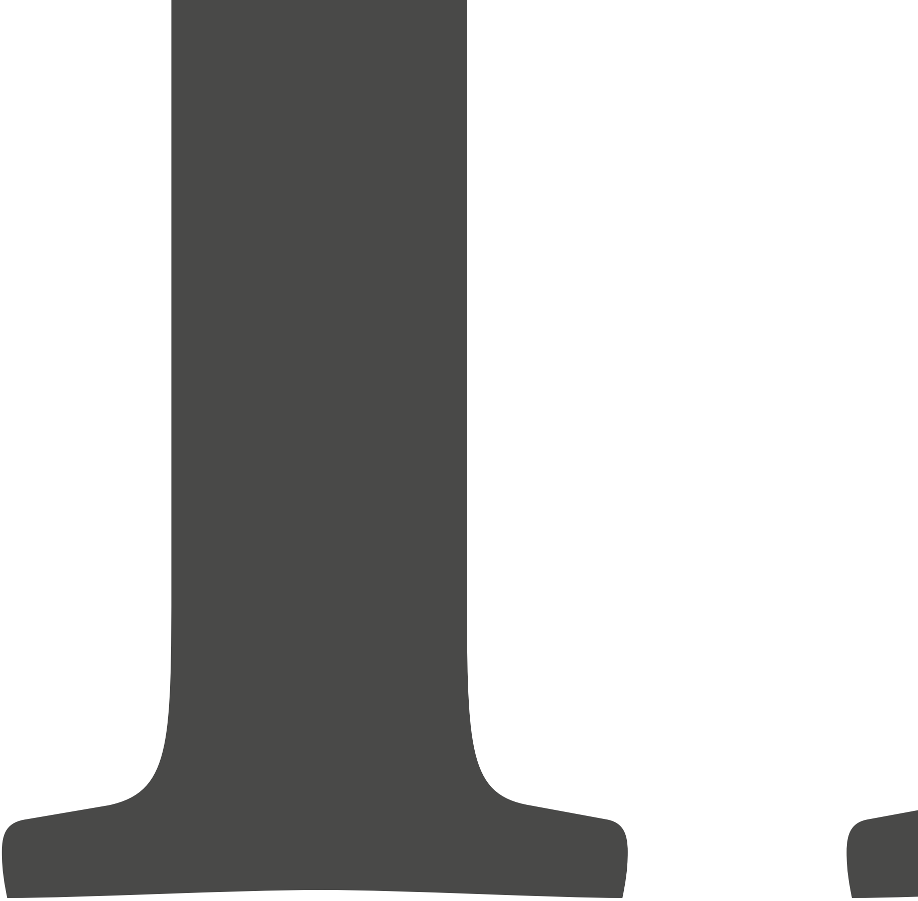




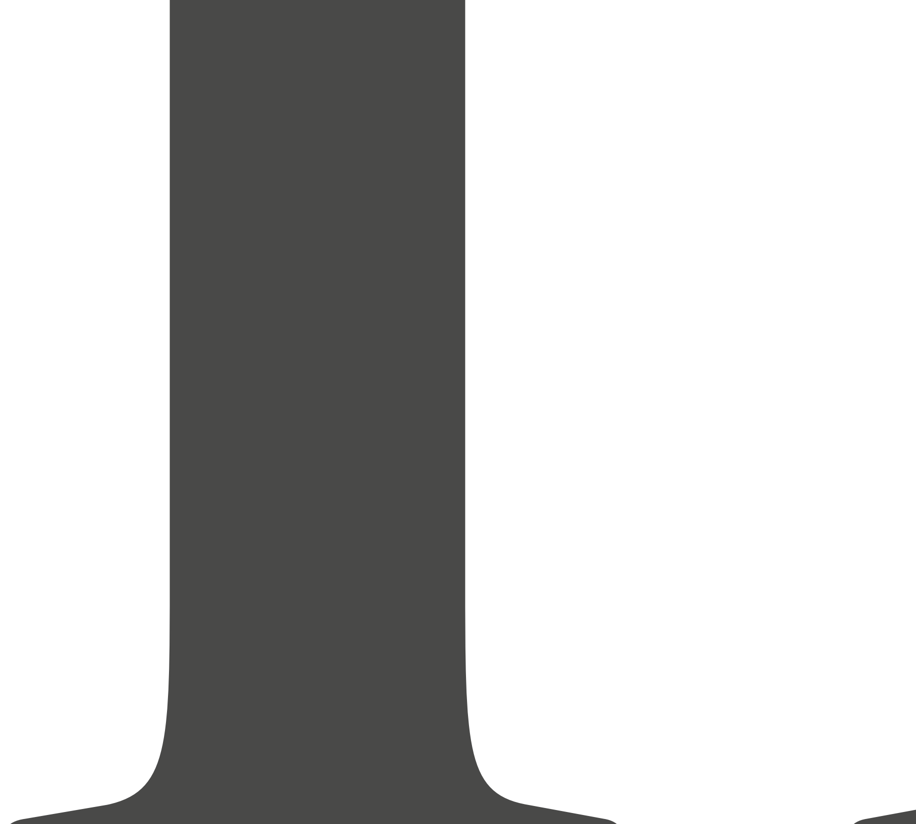
a

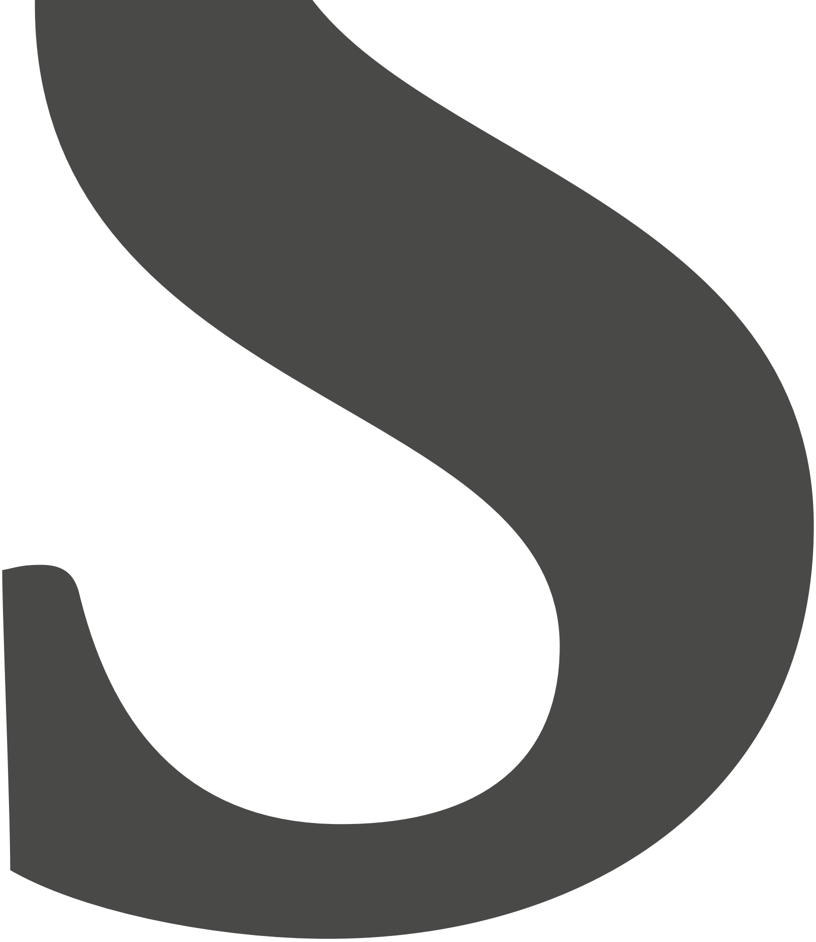
1

K



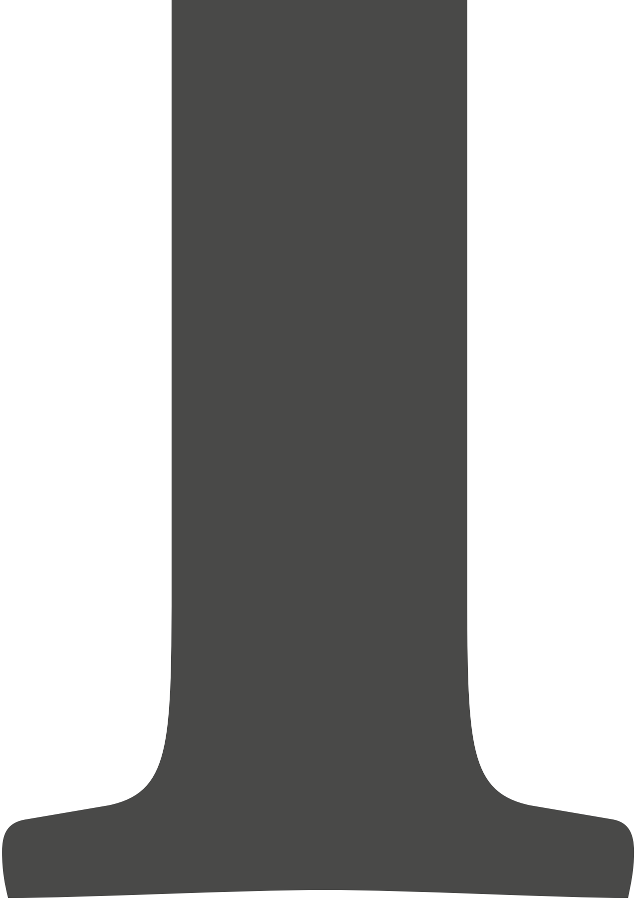
V

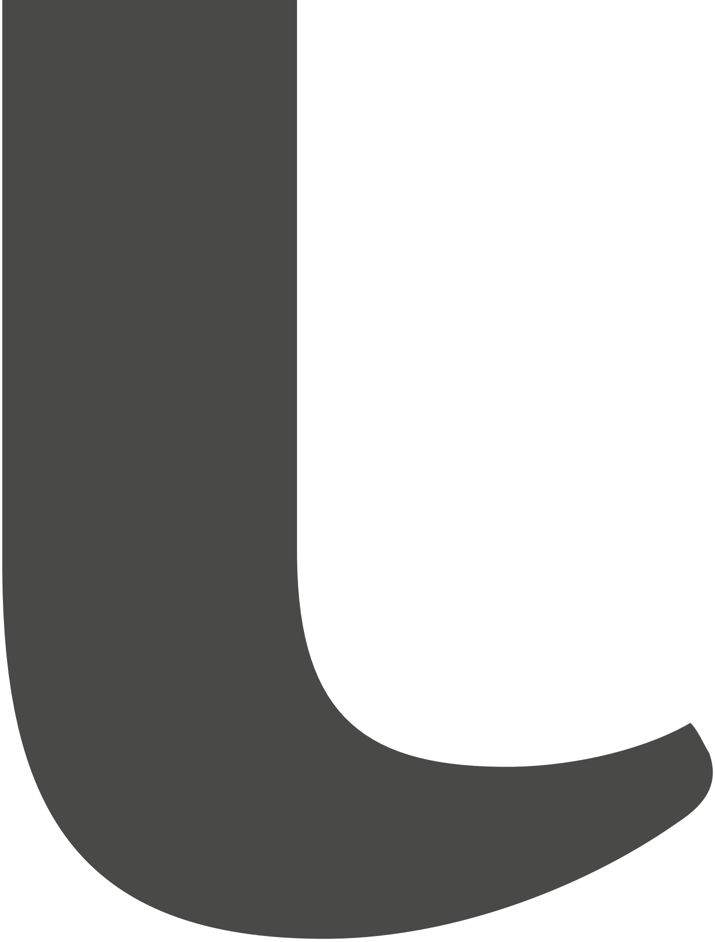


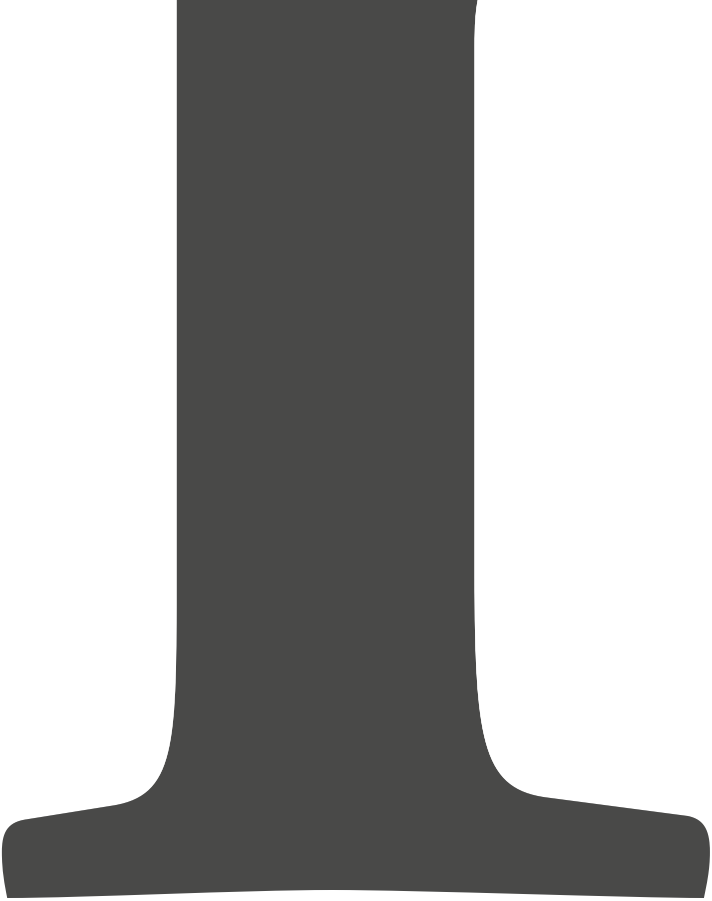


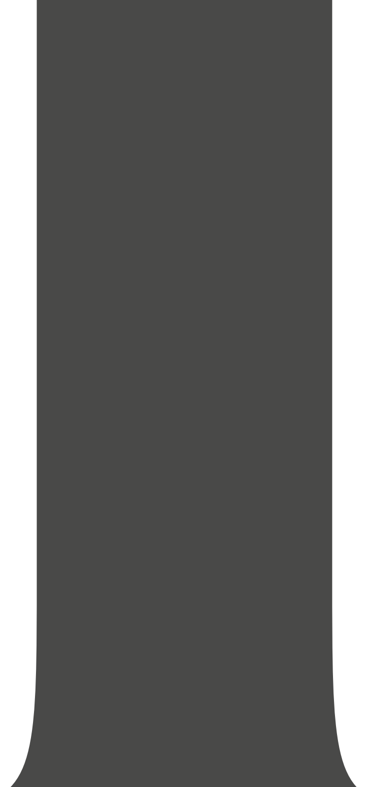
J

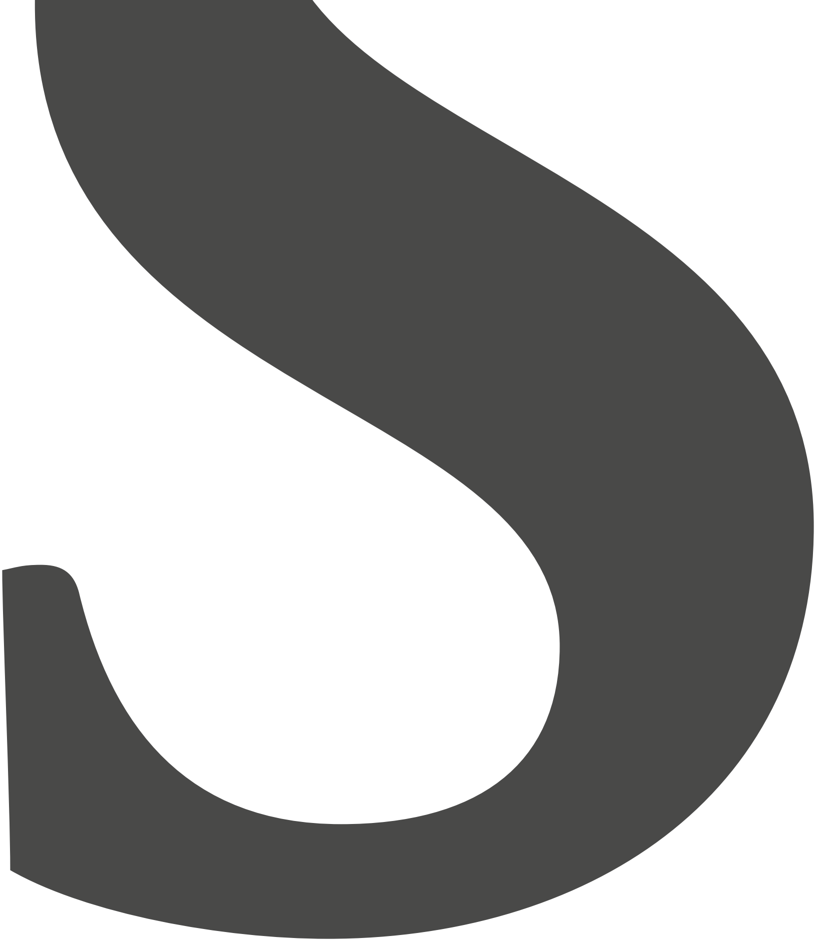
K

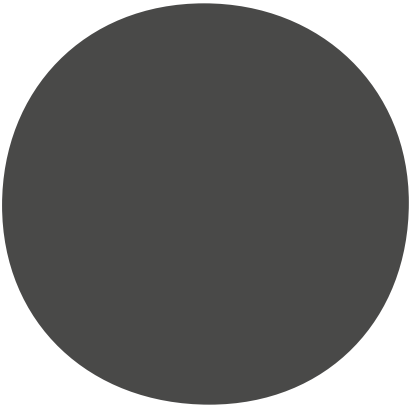












Pumpkin

Pumpkin vine

A pumpkin vine is long and curly, and creeps sideways over the soil. If it reaches a post or fence, its tendrils twist around it for extra support. The vine's flowers are male or female. It is part of the fertilized female flowers that swell into pumpkins.

[redacted]

U

IV

[redacted]

[redacted]

A

Si

it

Vi

fe

P

D

fr

F

M

Pu

le

w

M

p

d

S

a

T

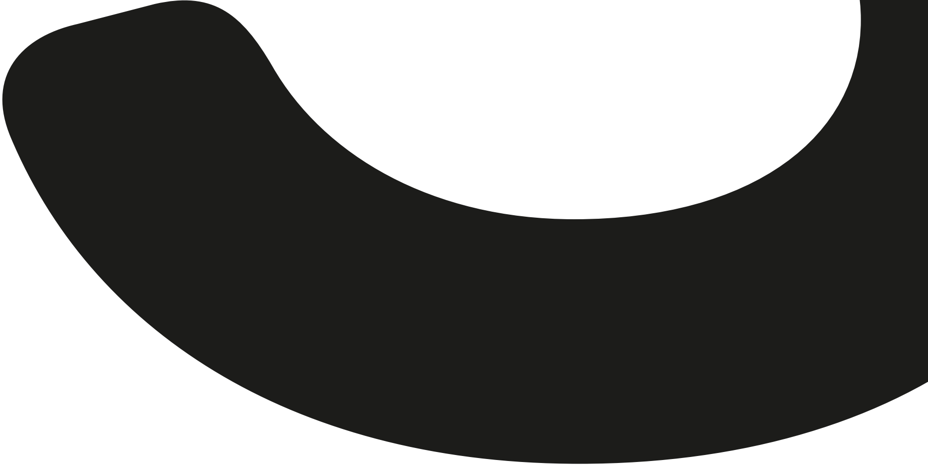
p

h

sk

b

m



M

s

st

th

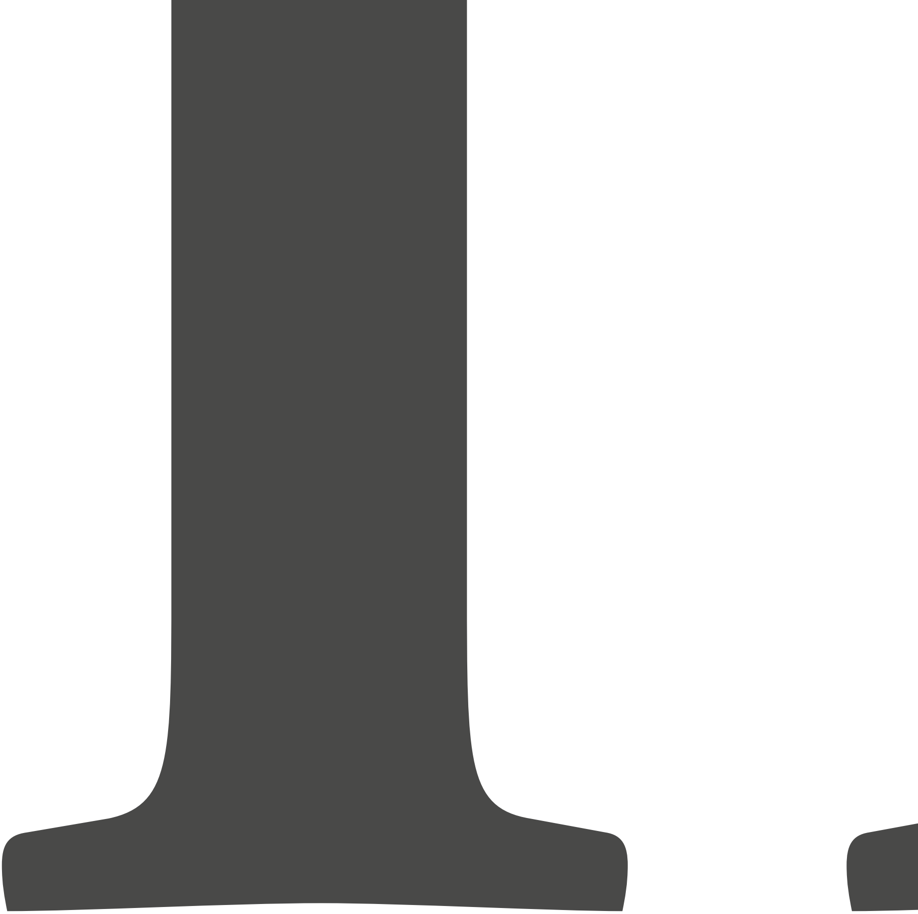
b

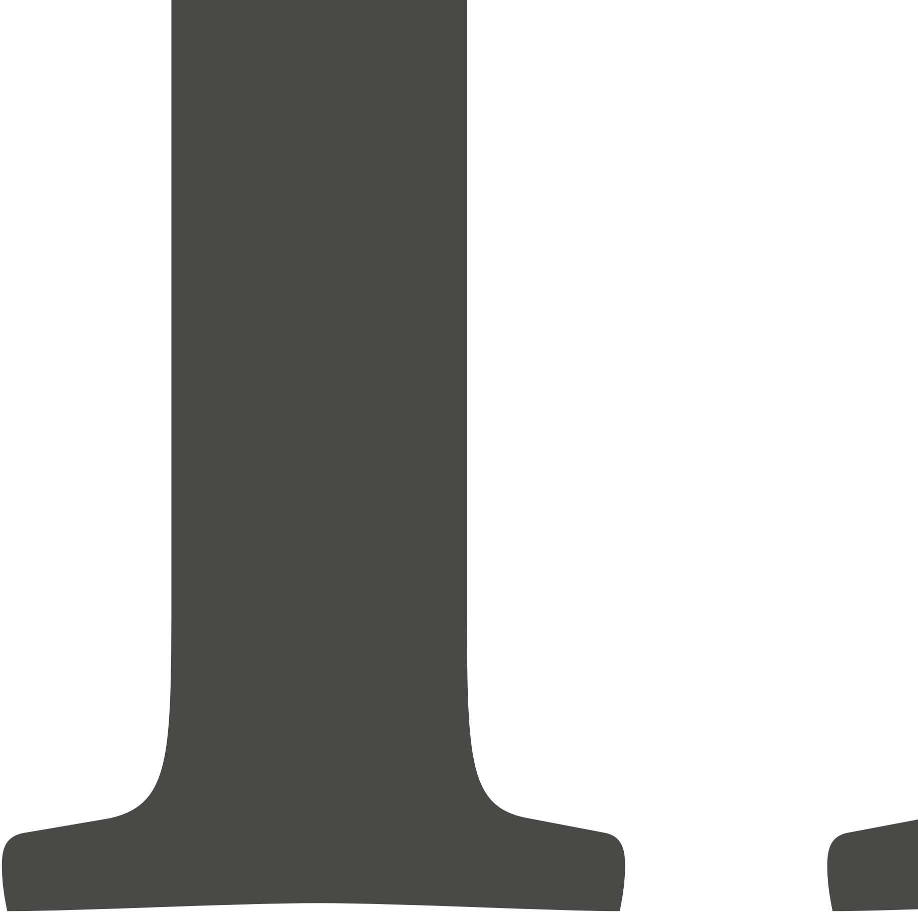
d

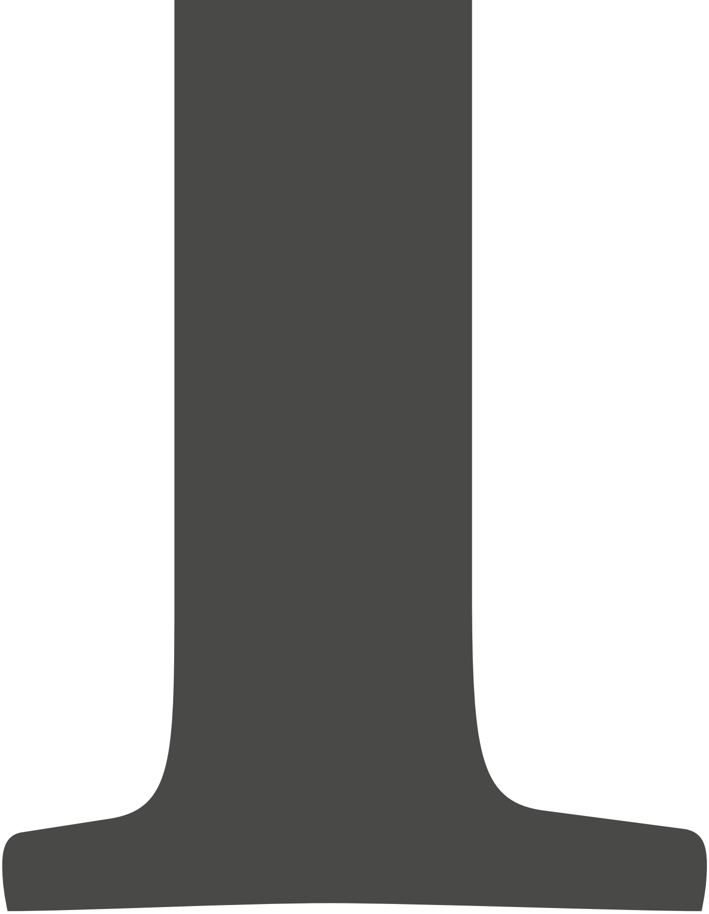
A

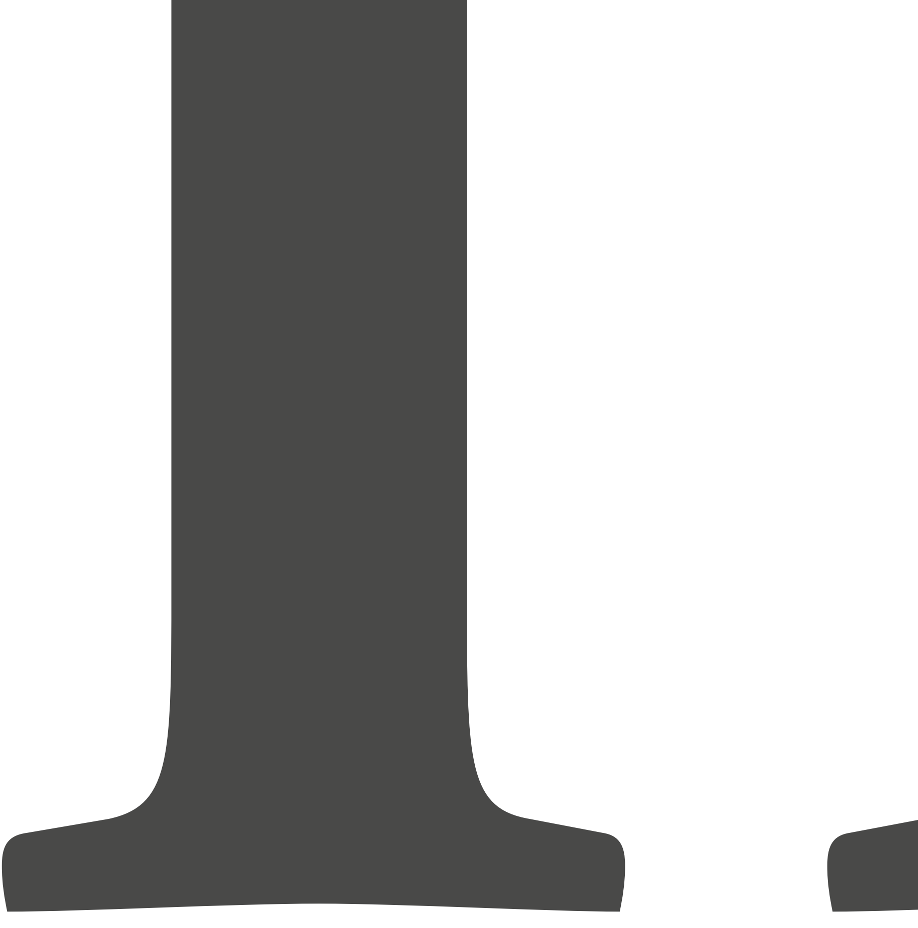
th

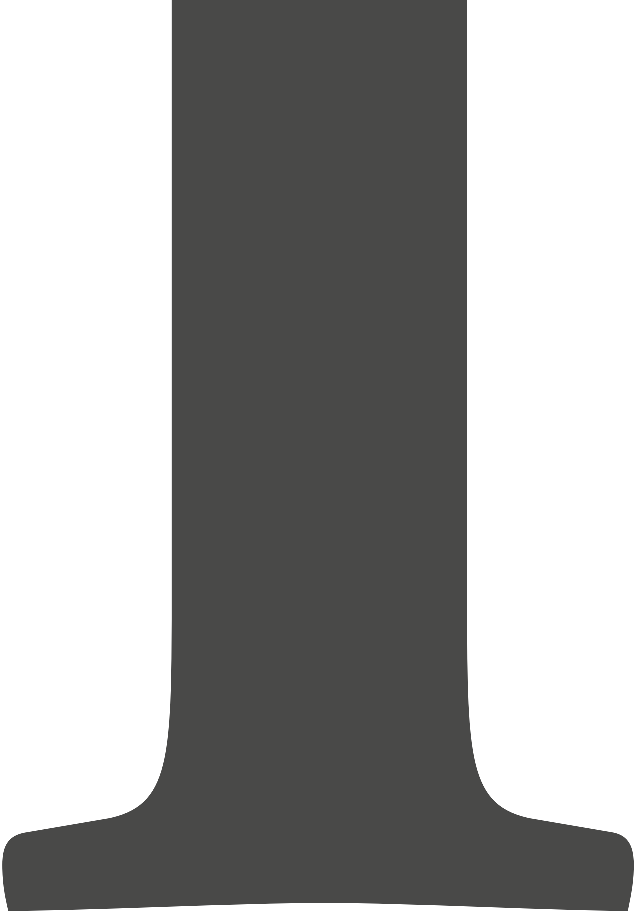
fl

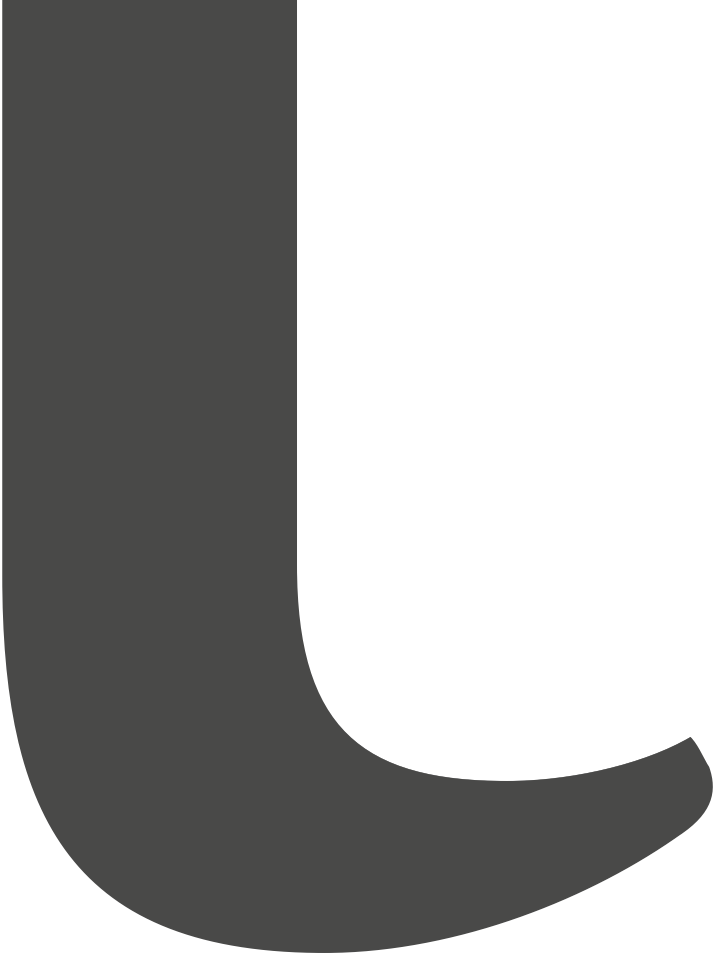


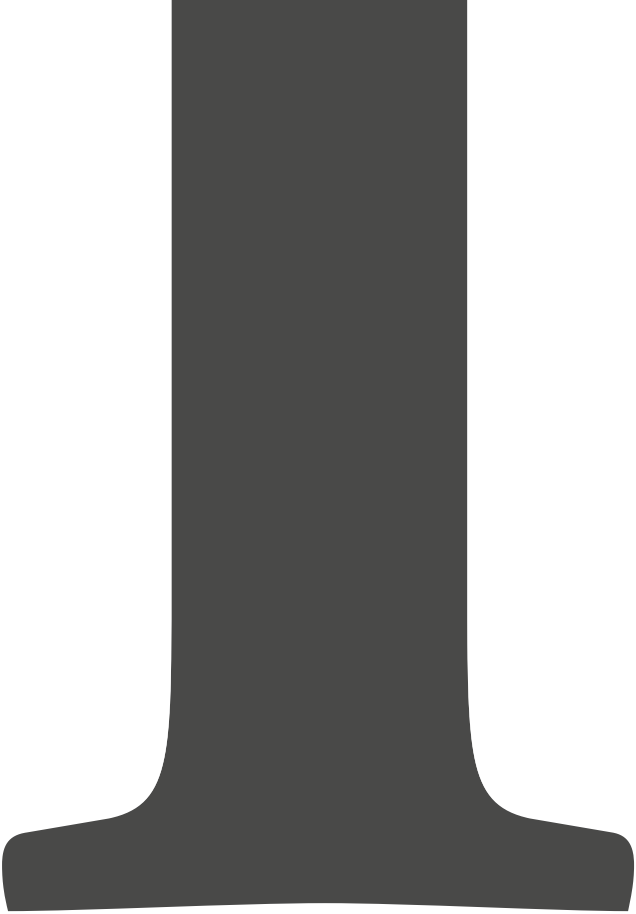


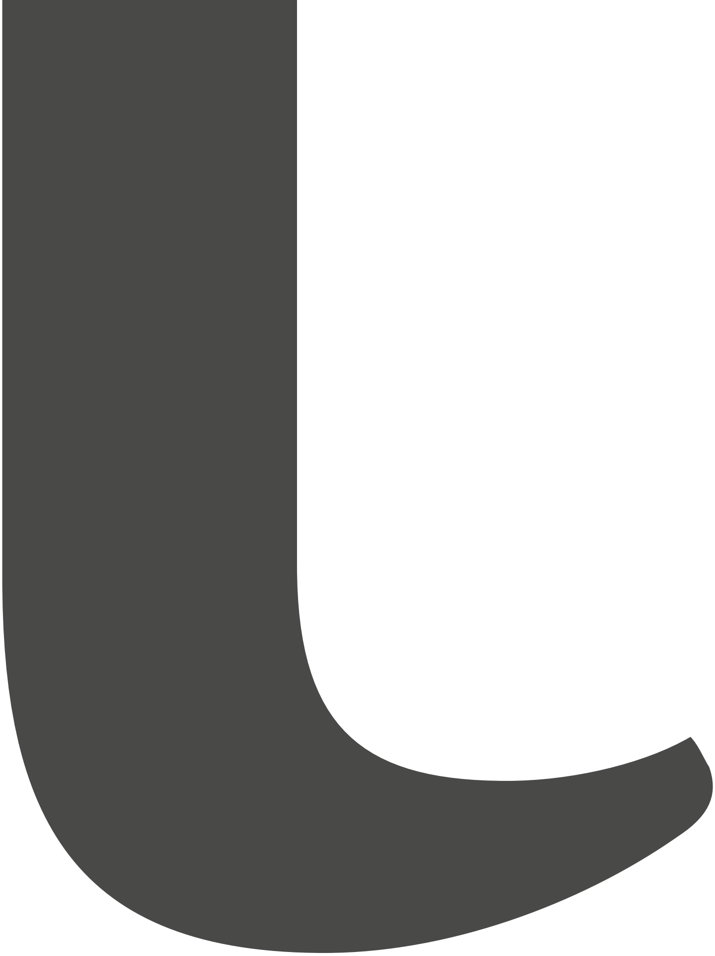


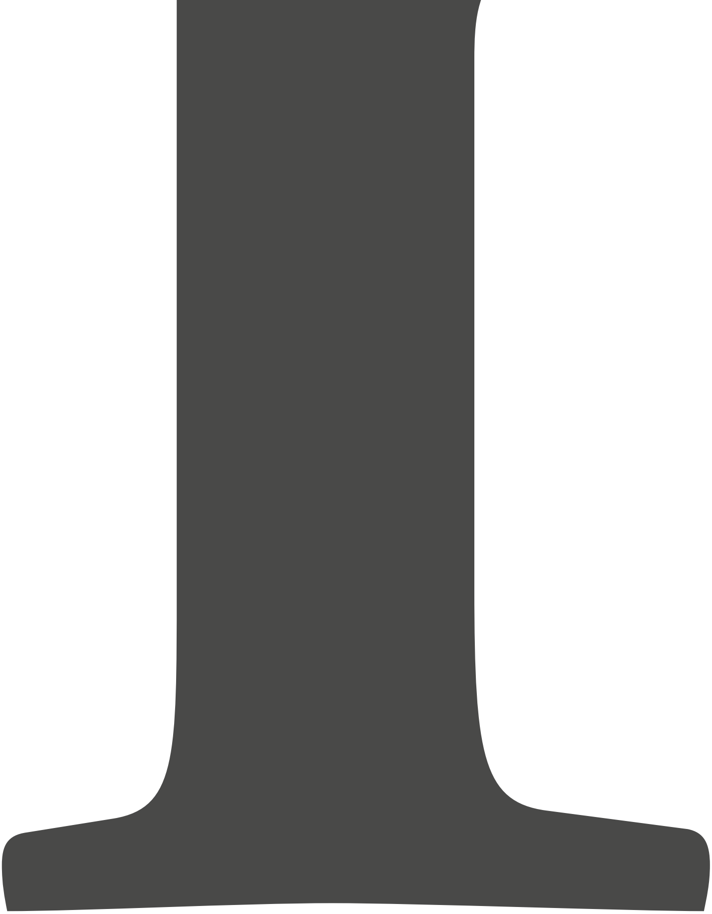


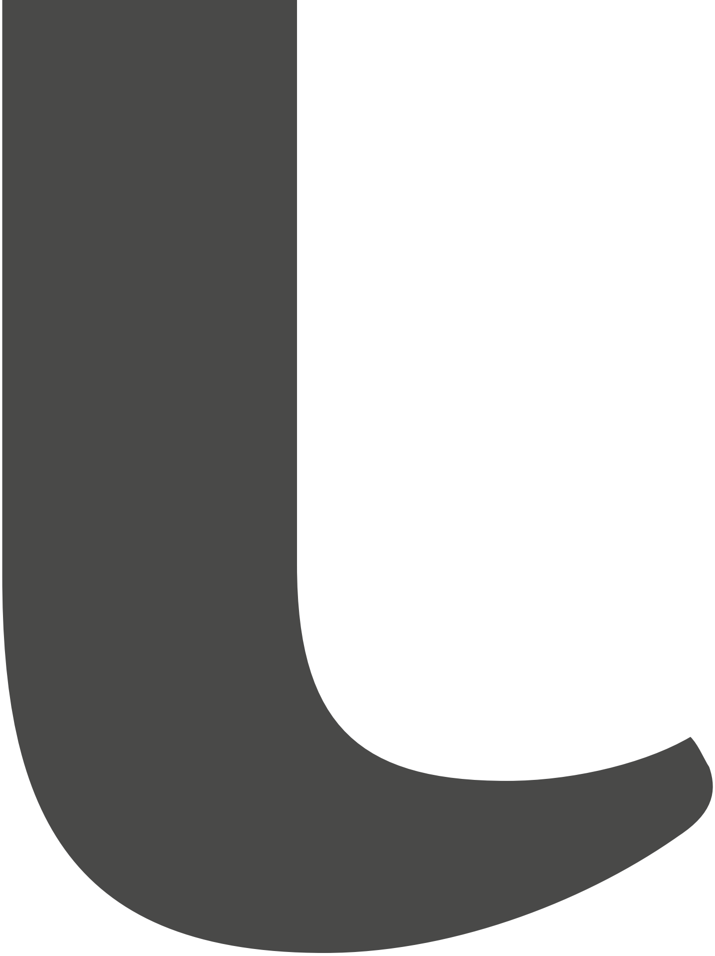


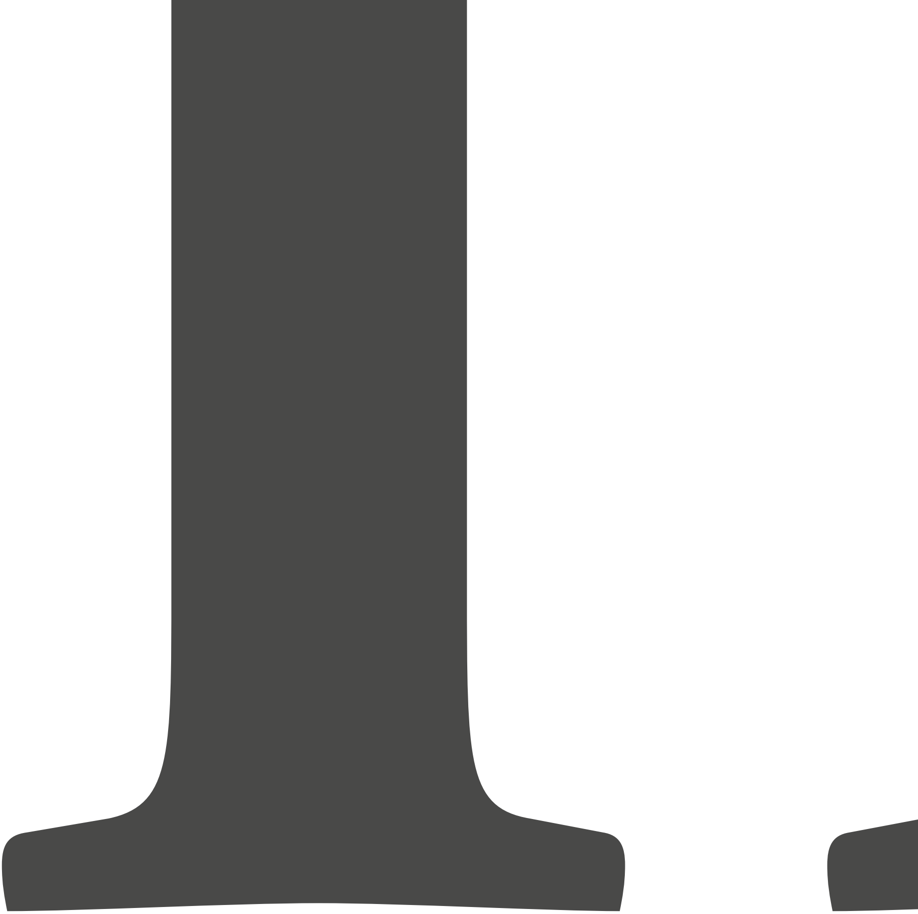


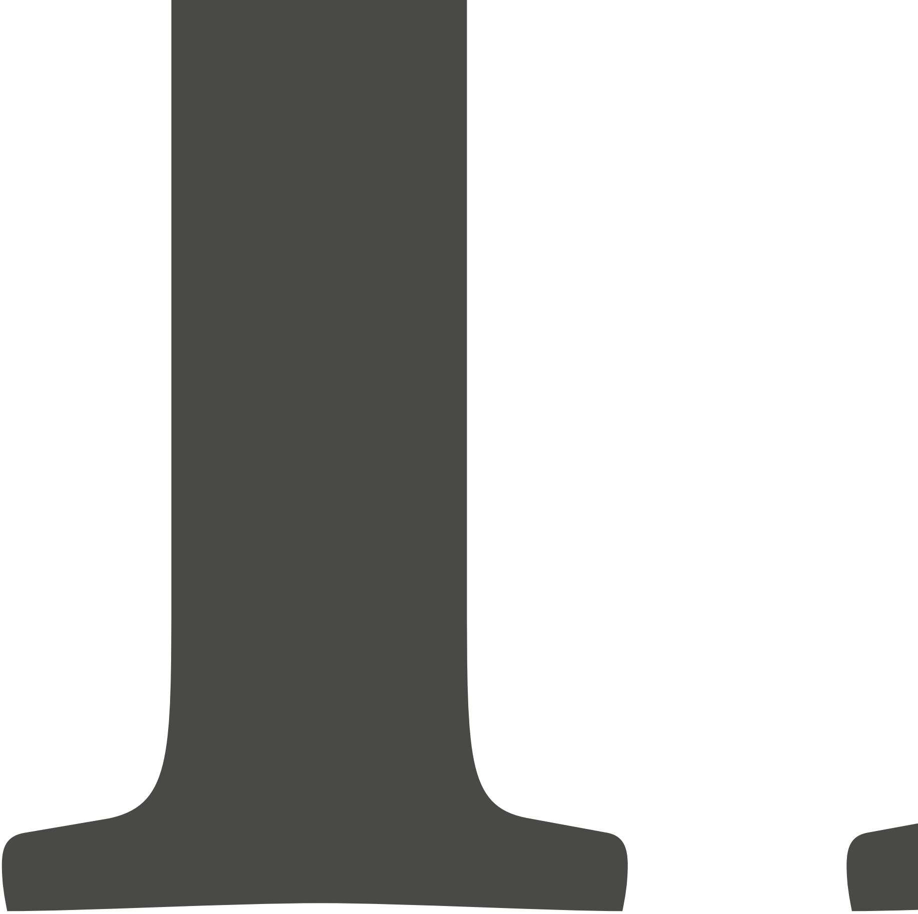




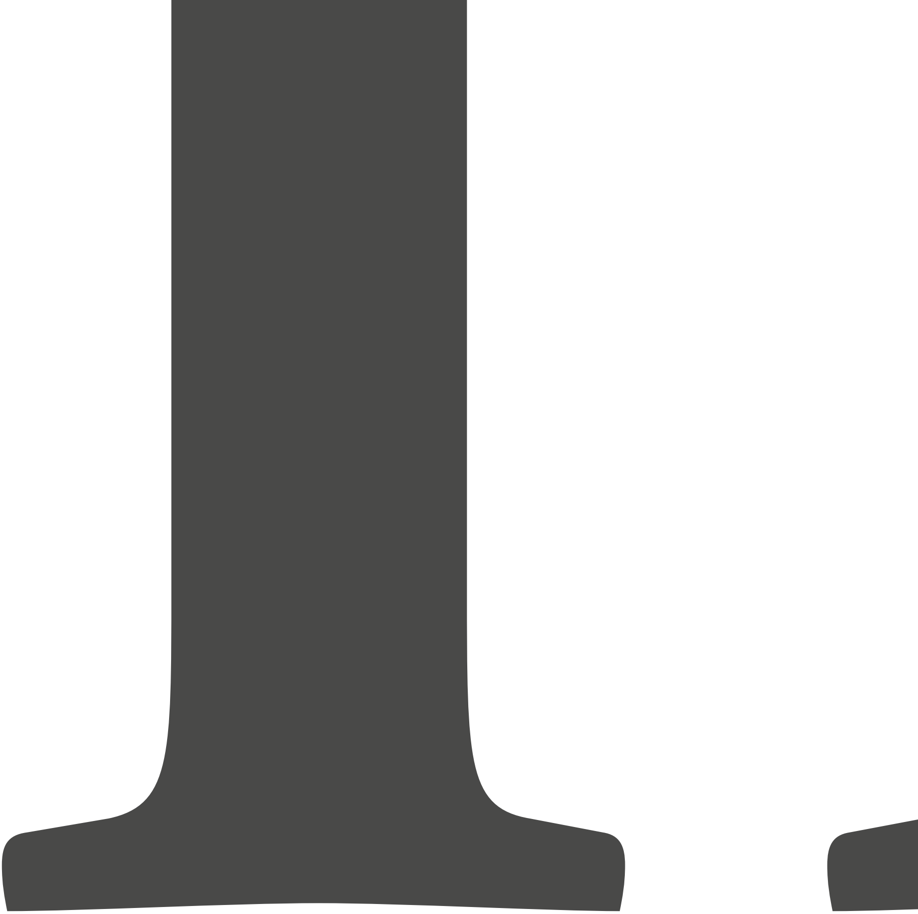


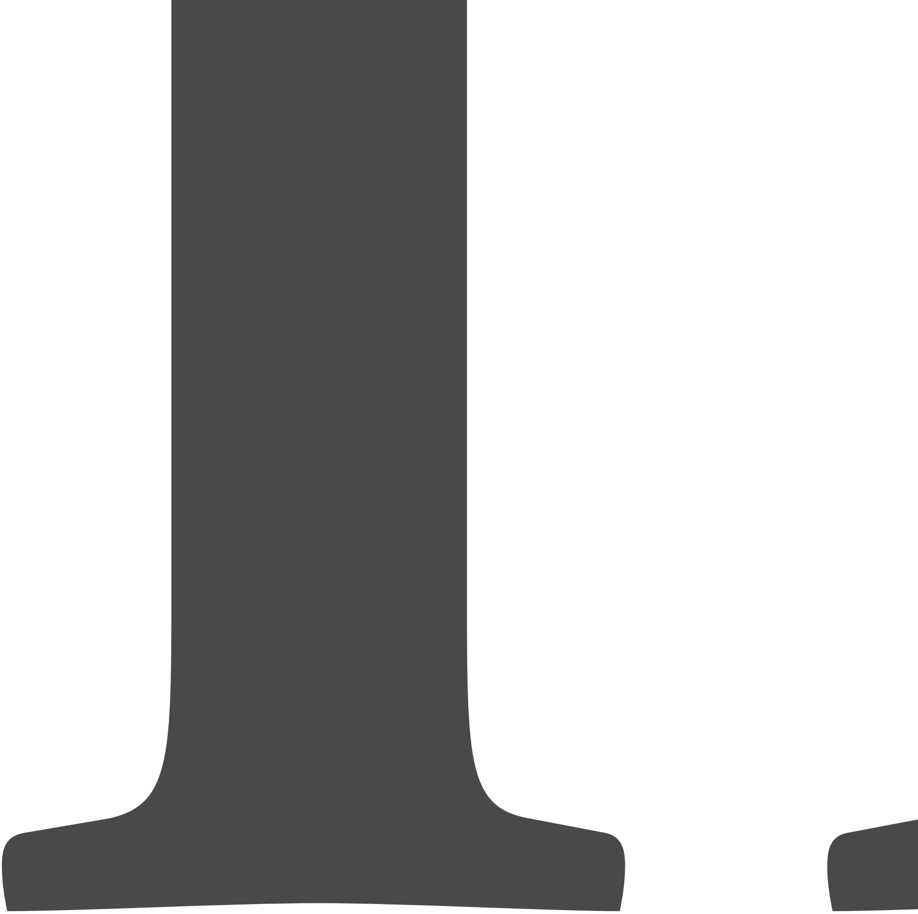


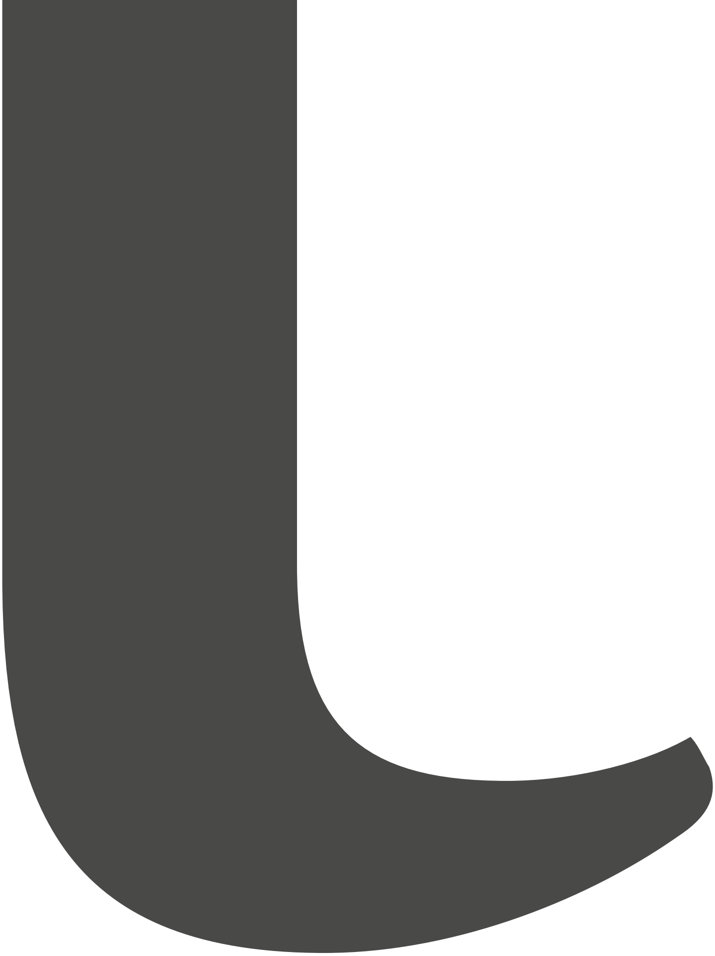


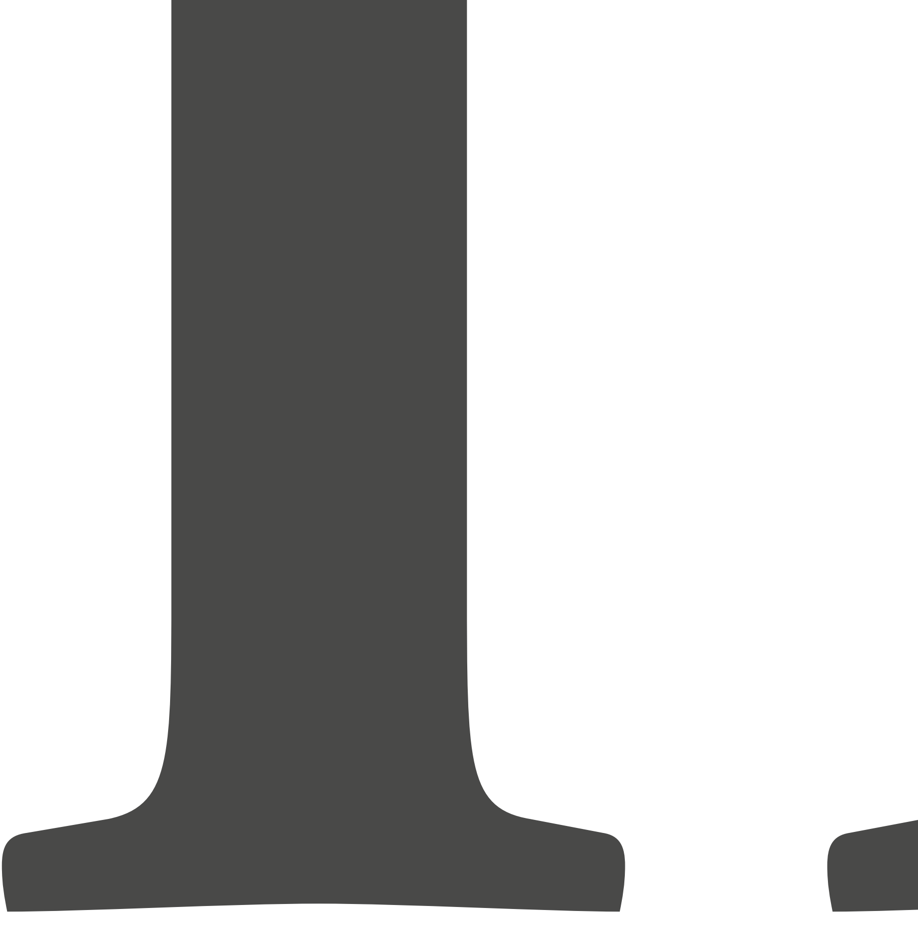


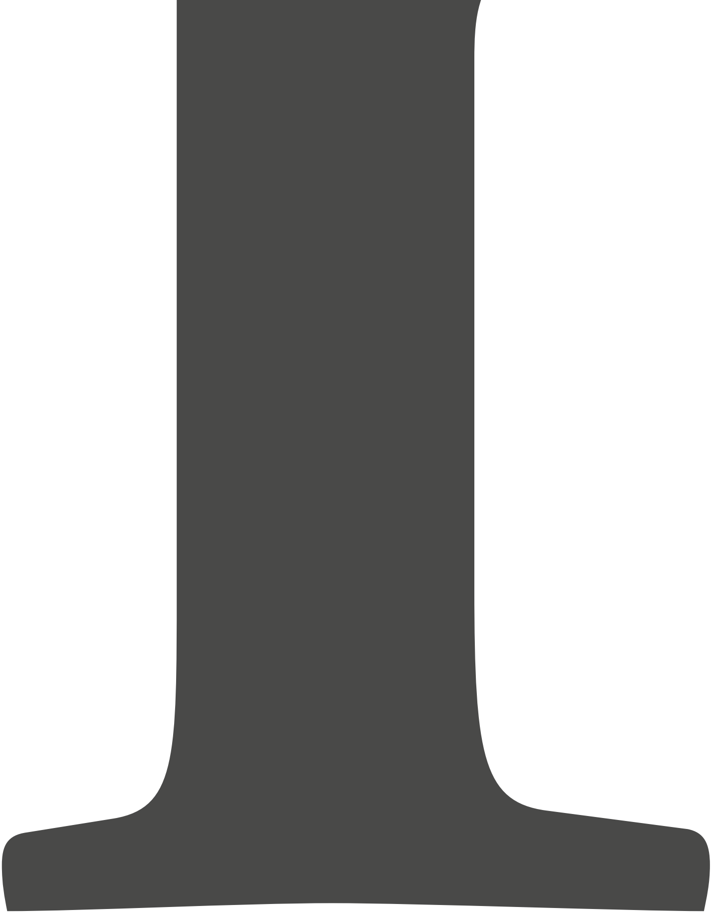
y

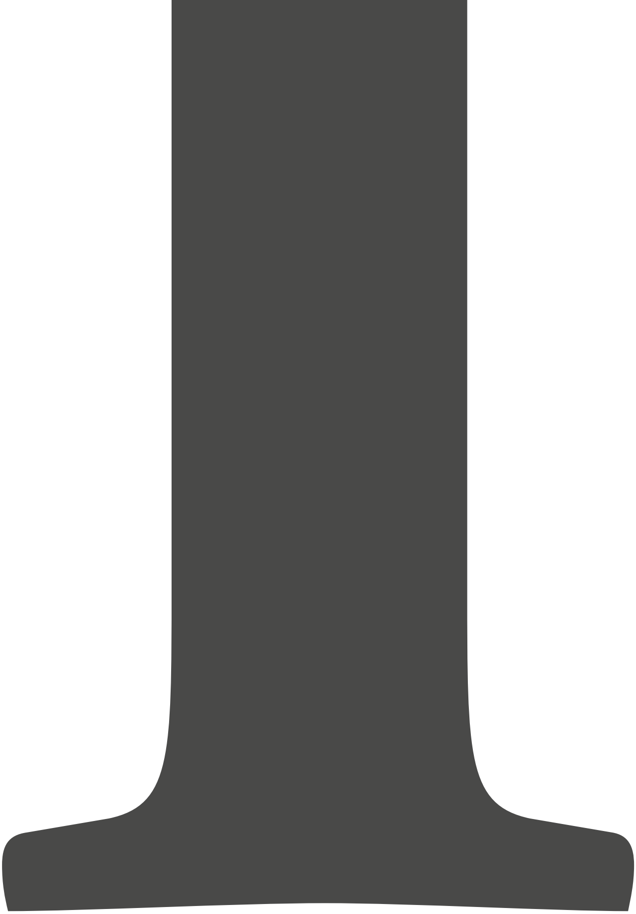


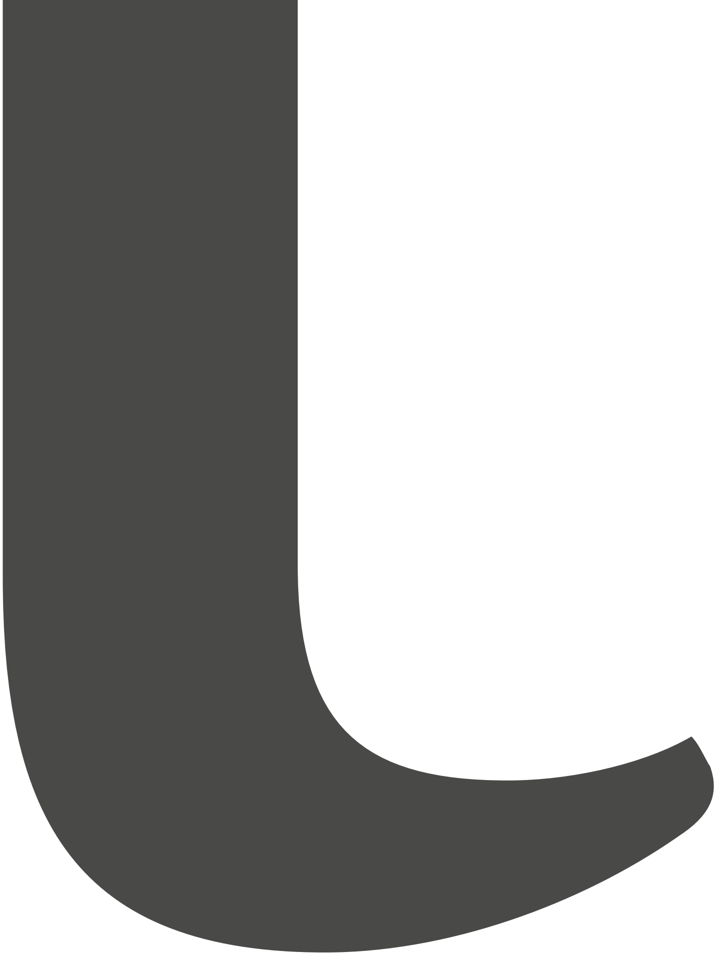


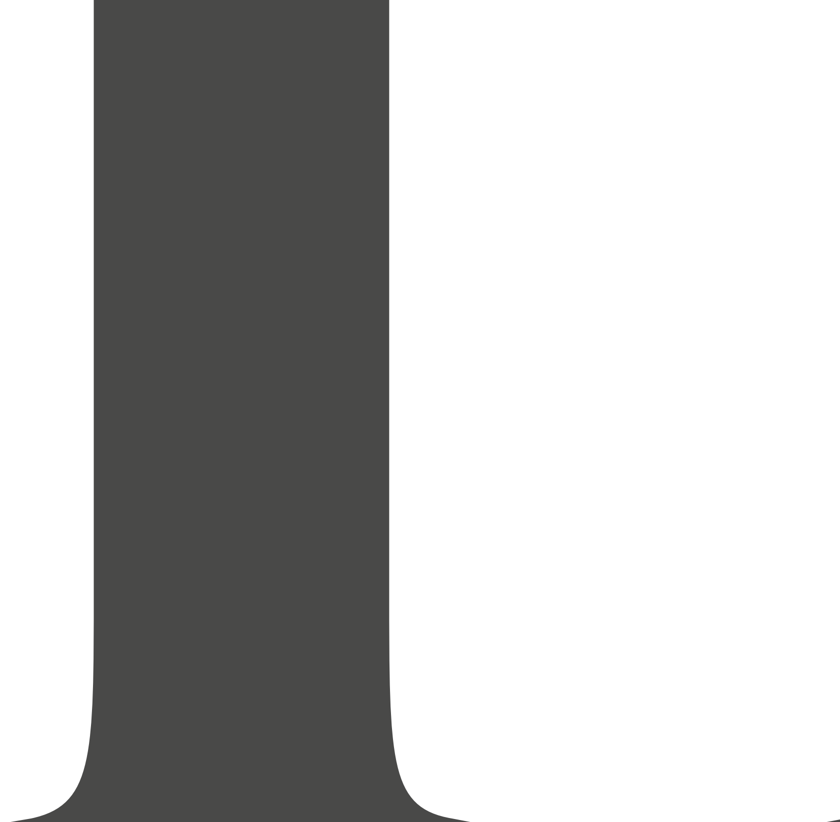






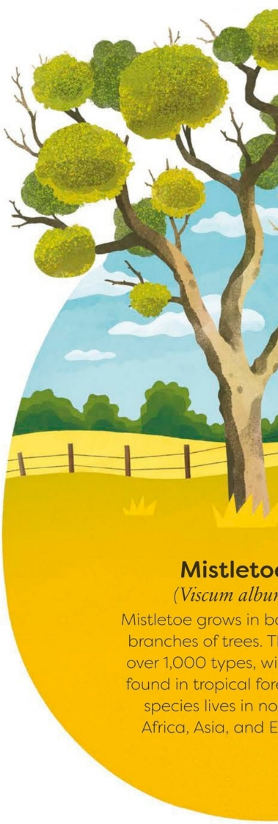




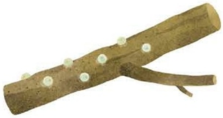


●

Mistletoe

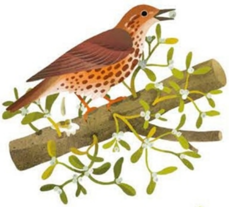


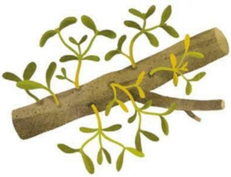
Mistletoe
(Viscum albu
Mistletoe grows in b
branches of trees. T
over 1,000 types, wi
found in tropical for
species lives in no
Africa, Asia, and E

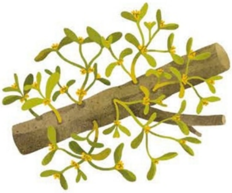


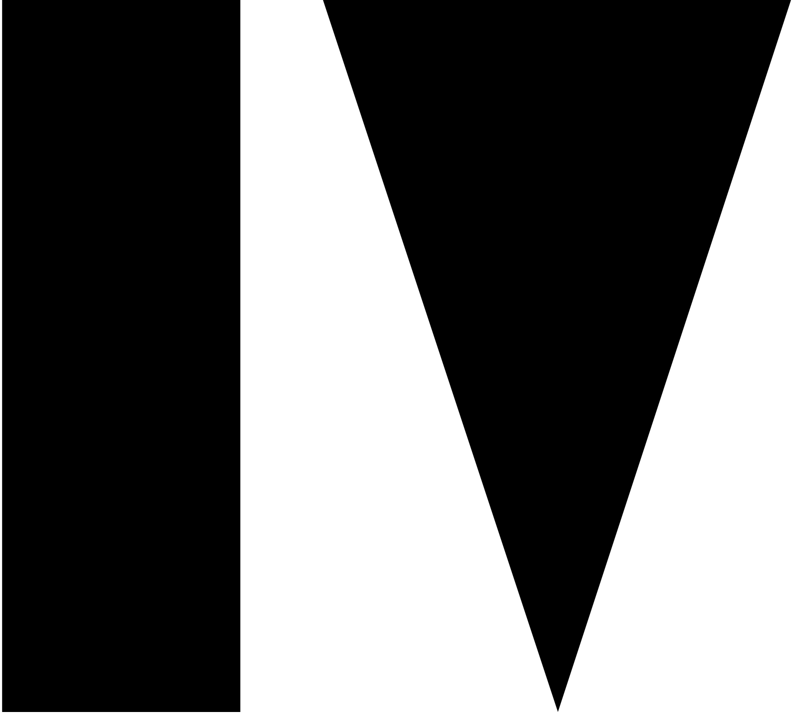
Moving around

Mistle thrushes feed on mistletoe berries, spreading the seeds in their poo. The seeds stick to the branches of their new host tree and send out a root that worms its way under the host tree's bark. The baby mistletoe plants then sprout leaves, and when grown, produce small flowers that turn into white berries.





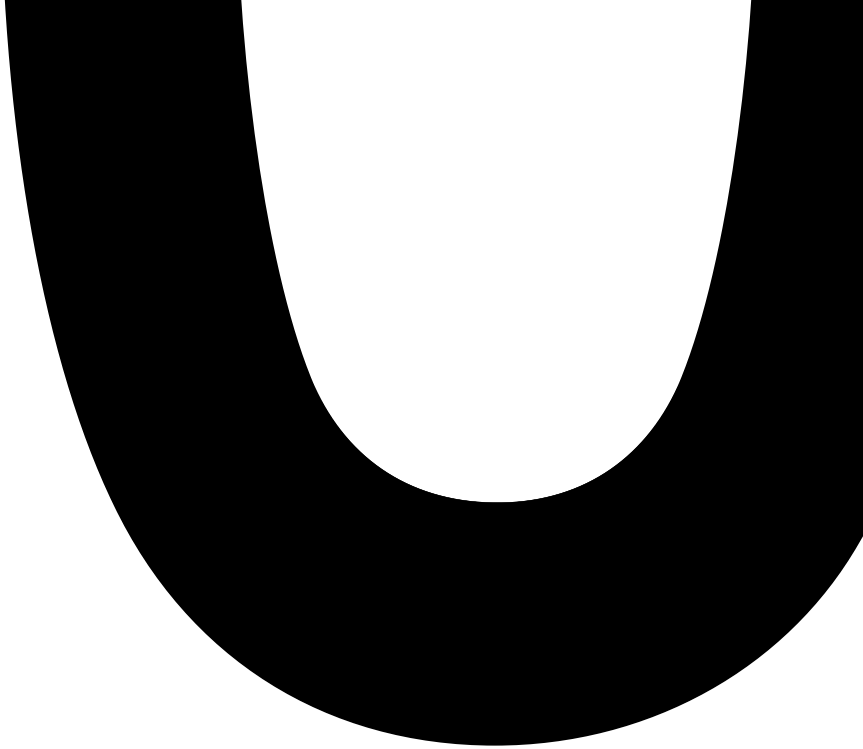




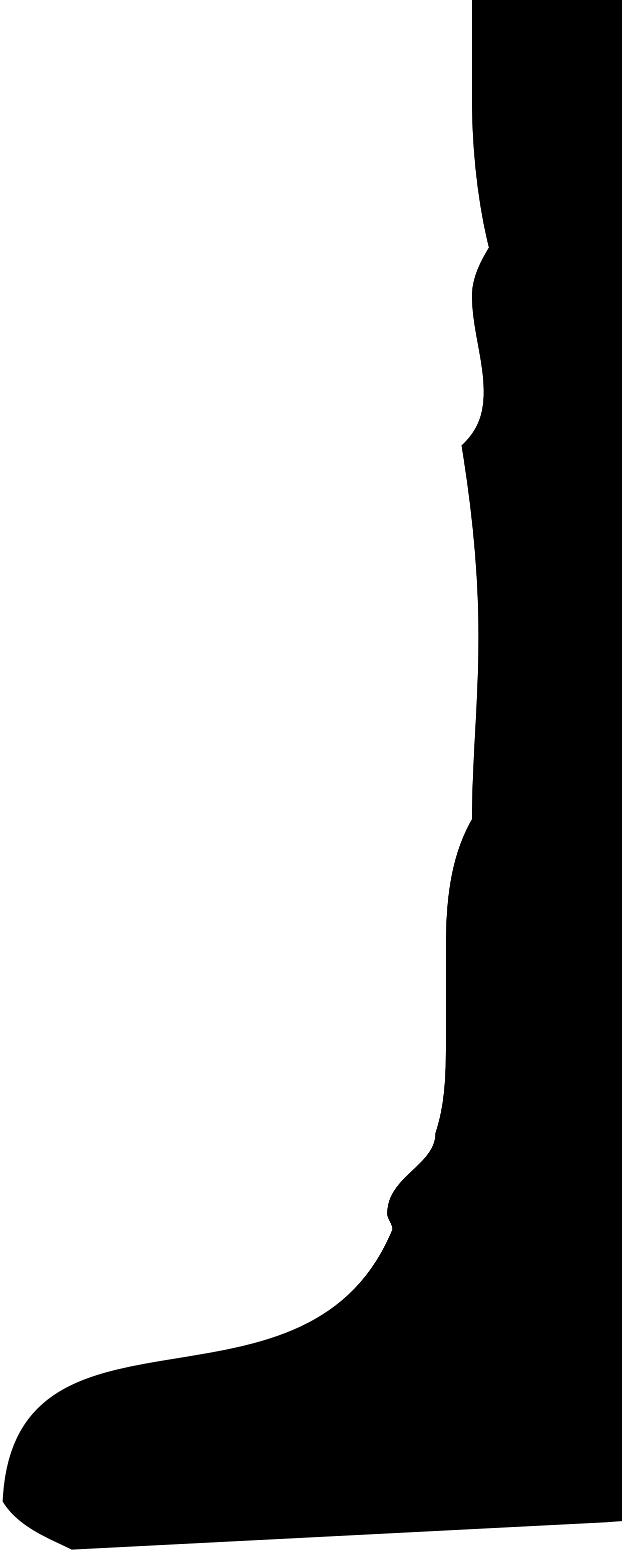
[redacted]

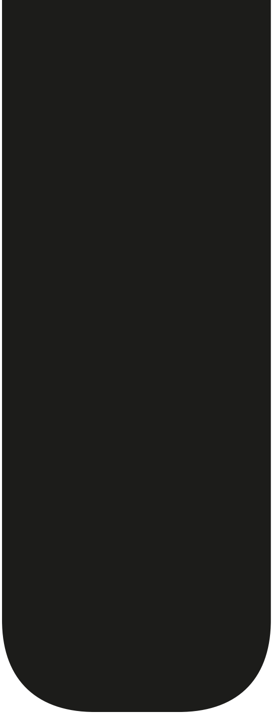
[redacted]

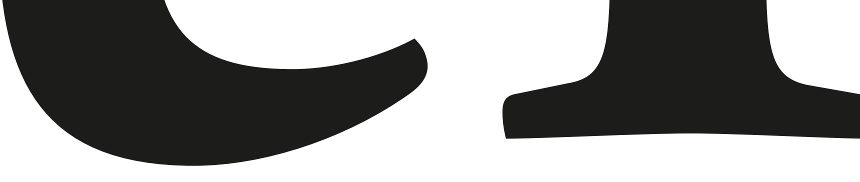
[redacted]

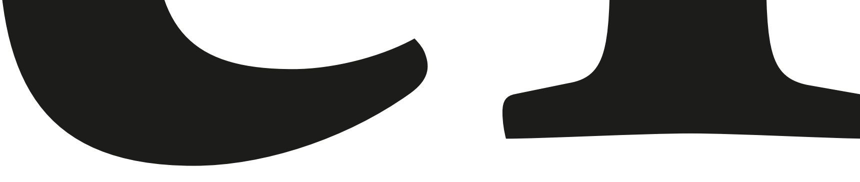


L









M

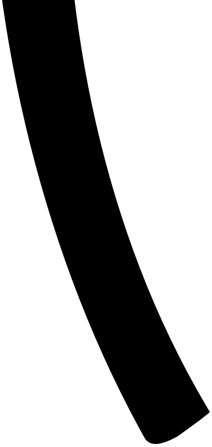
th

O

it

p

s



M

b

O

f

sp

A

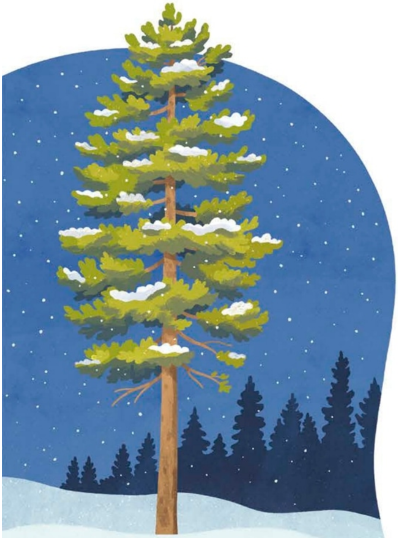
S

S

F

S

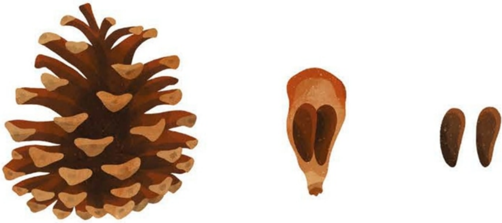
Lodgepole pine



Lodgepole pine
(Pinus contorta)
Lodgepole pines form great forests in western North America, often by the coast and on the slopes of the Rocky Mountains.

Inside a cone

A female cone takes two years to mature. By this time, it is hard and woodlike, built from lots of tough scales. On every scale are two tiny seeds that are released when the cone opens.



A

t

a

t

t

W

L

g

A

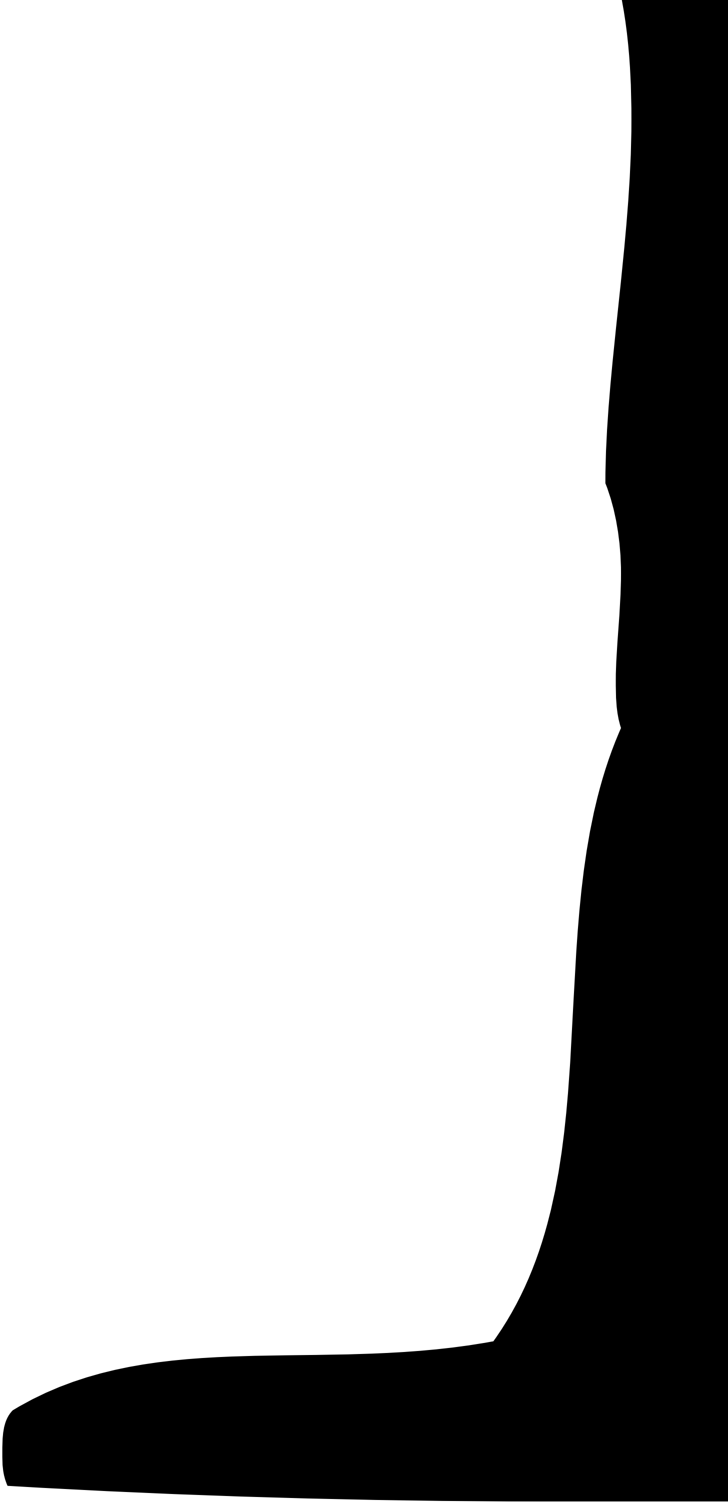
a

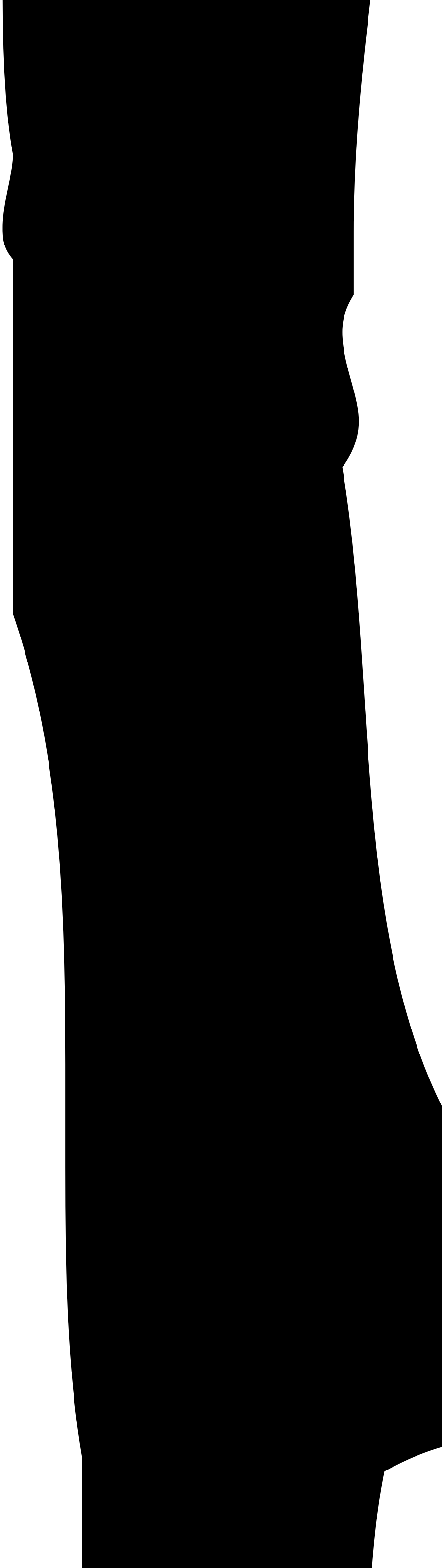
R

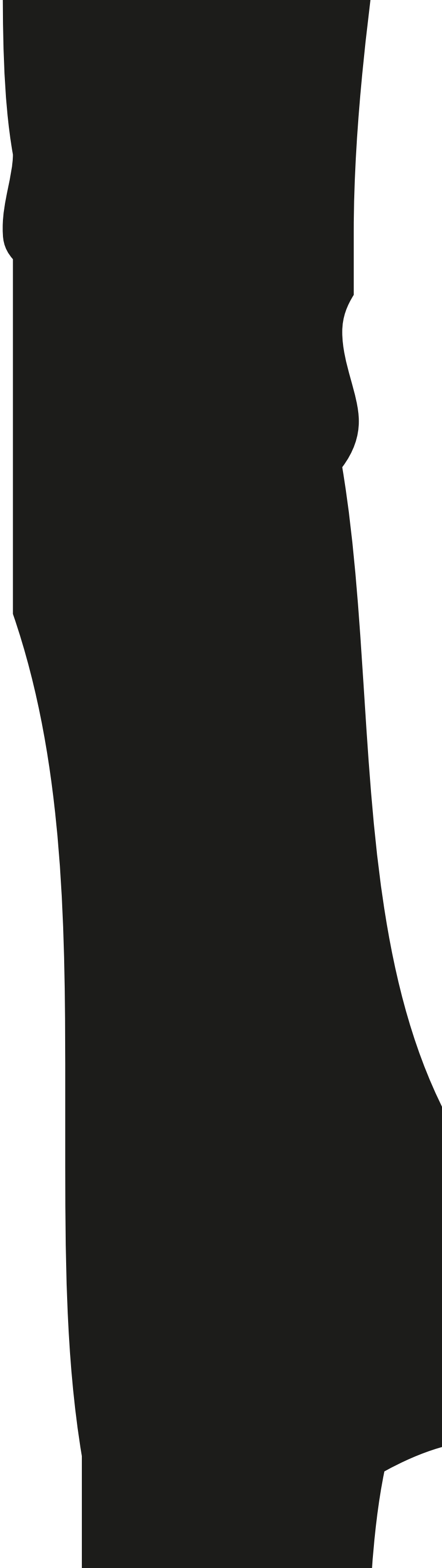
C

S

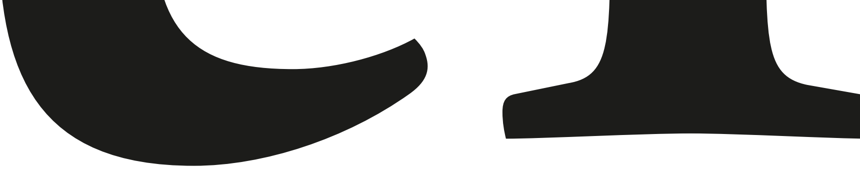
S

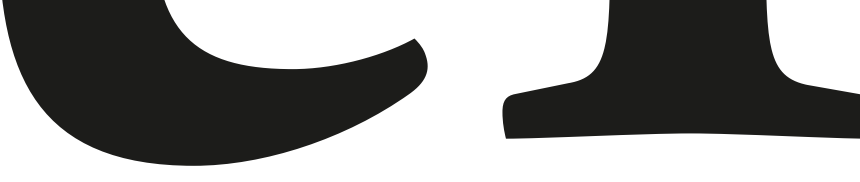


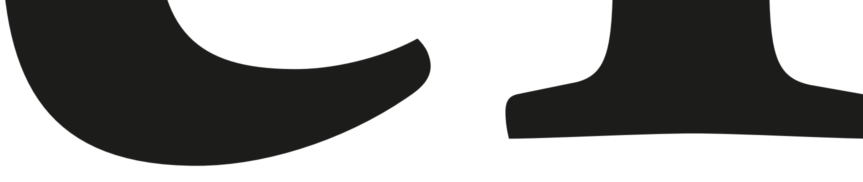




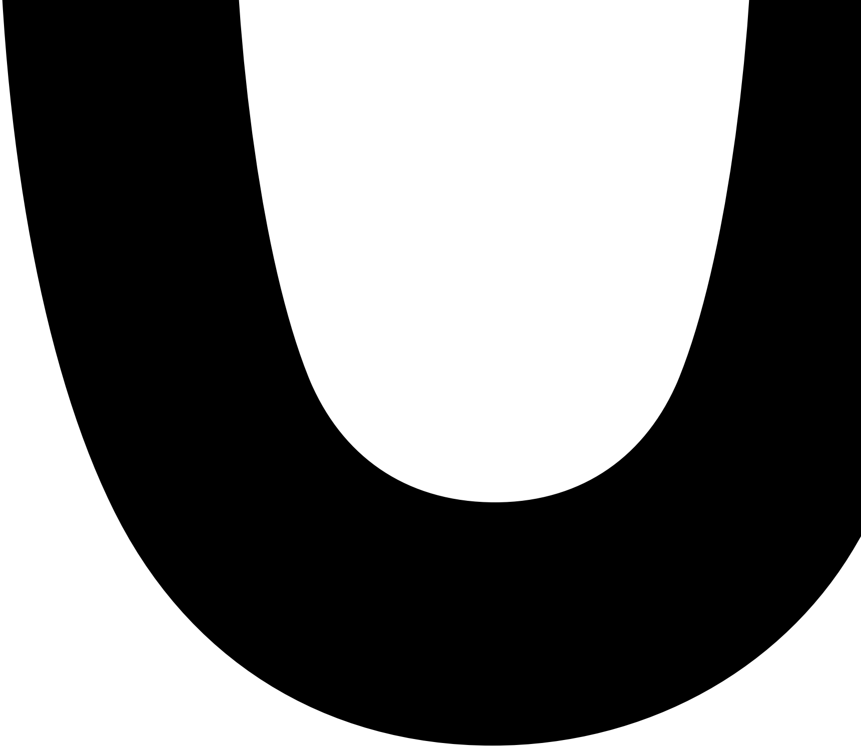
V





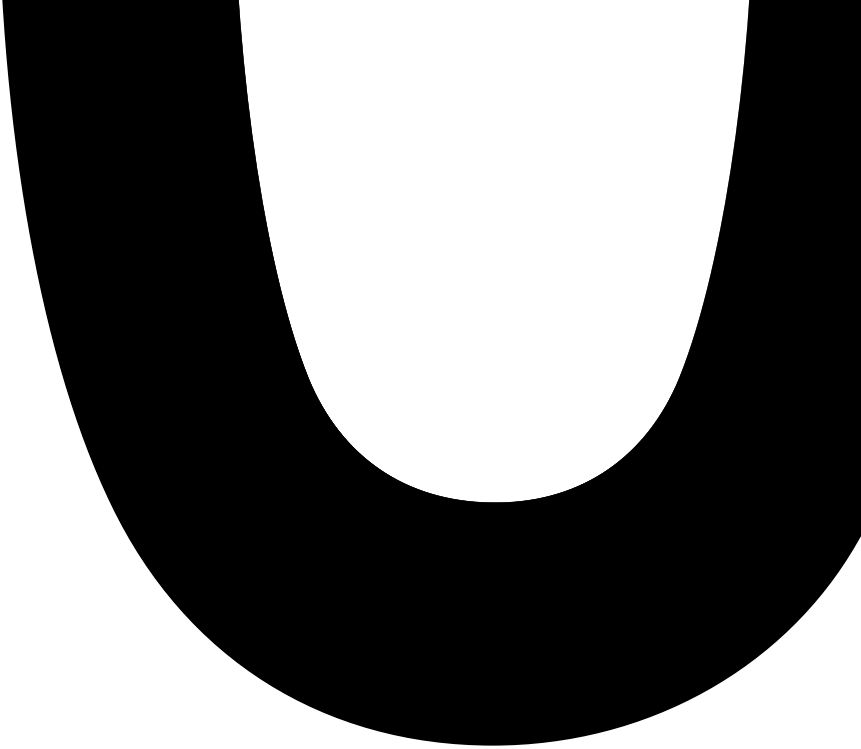


LODGEPO



G

[redacted]



[redacted]

[redacted]

lf

it

SU

se

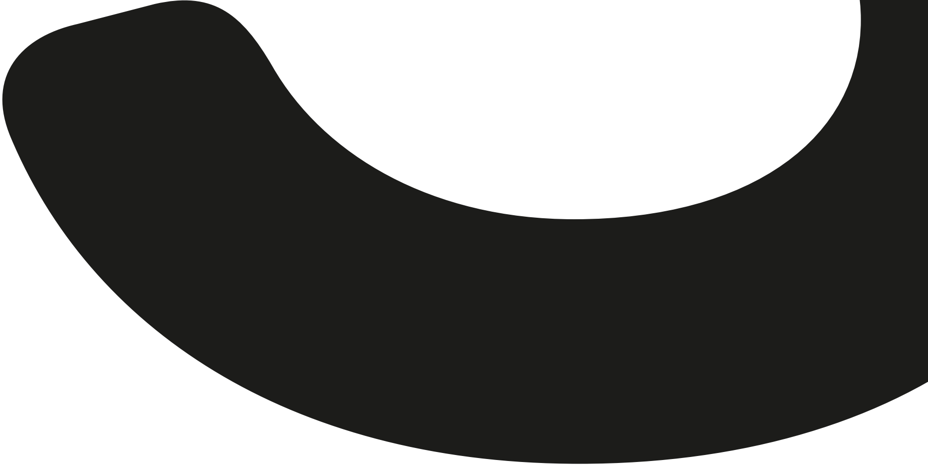
d

T

CE

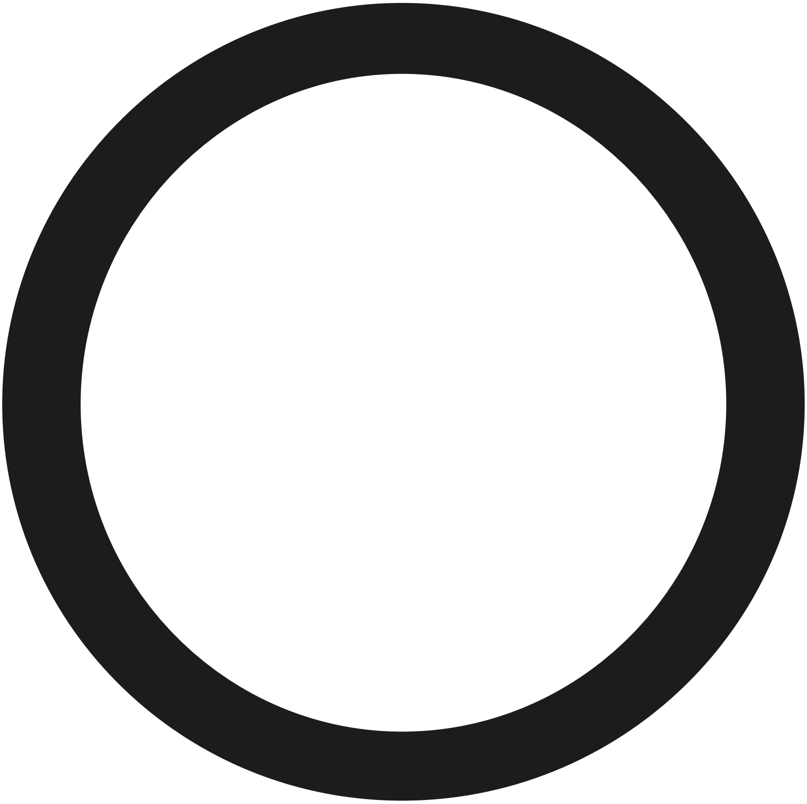
m

in



T

t



a

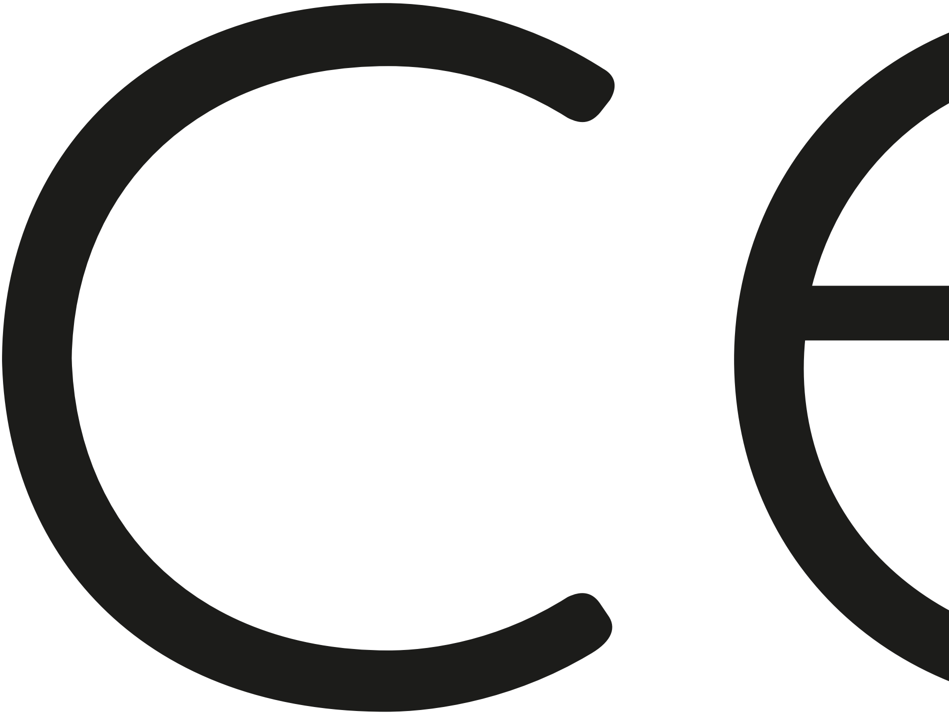
P

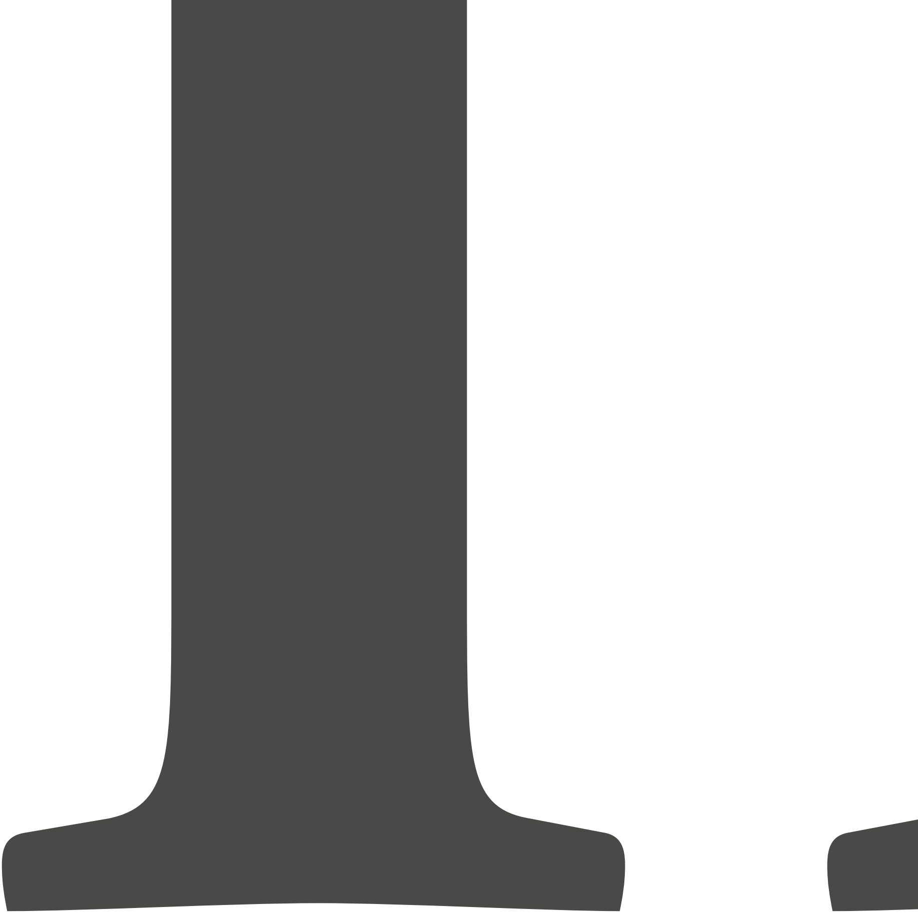
S

C

T

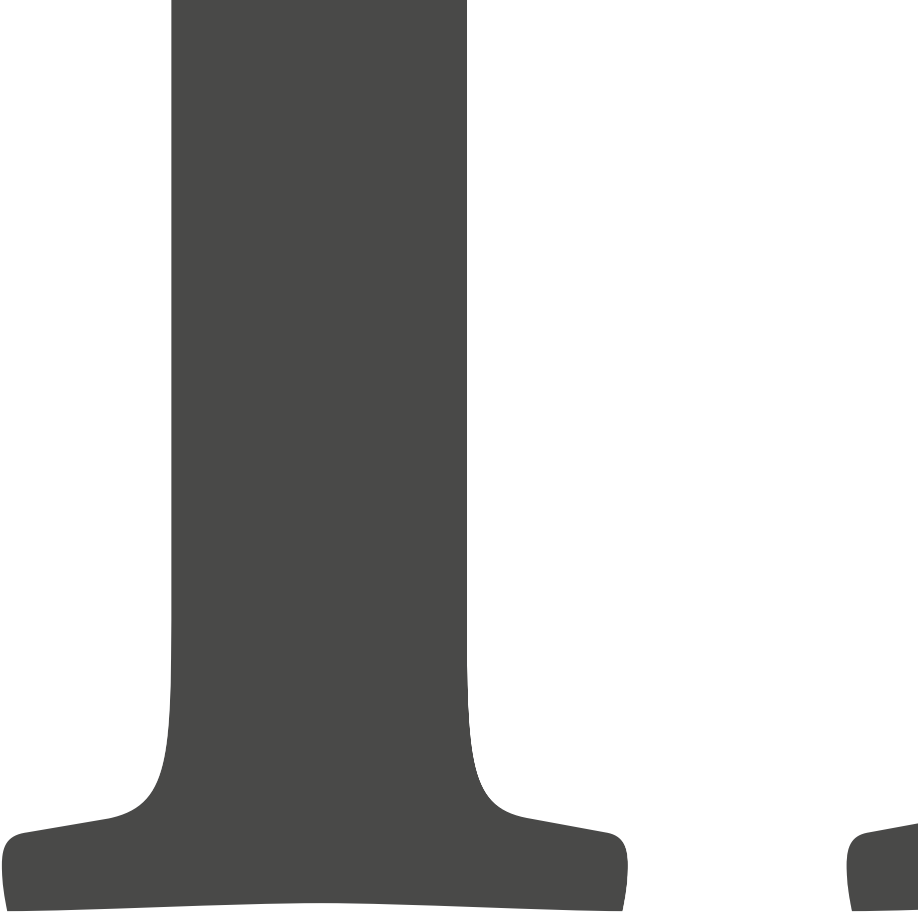
hi

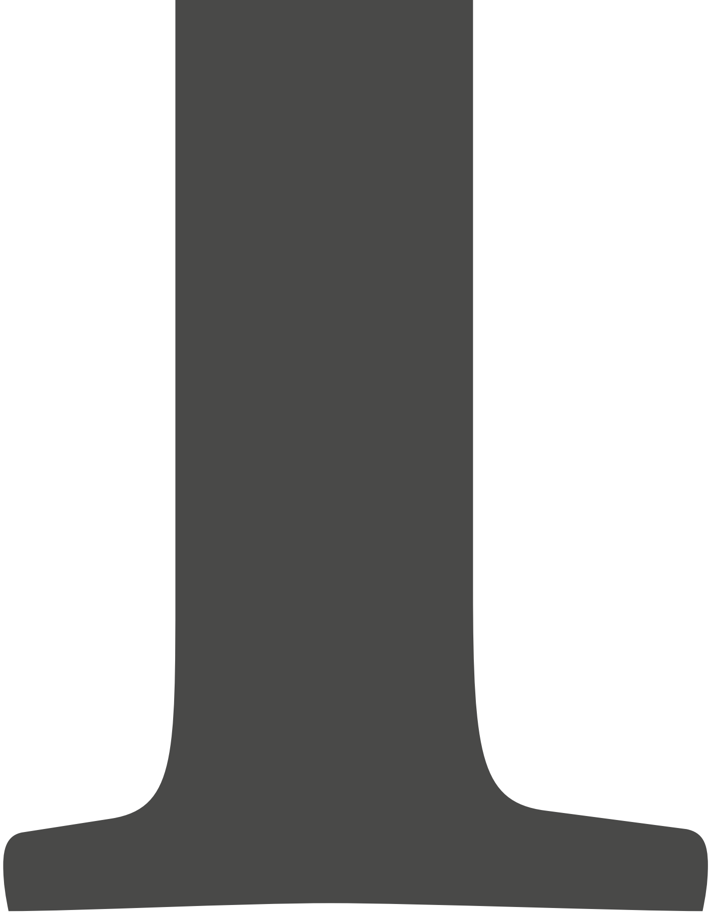


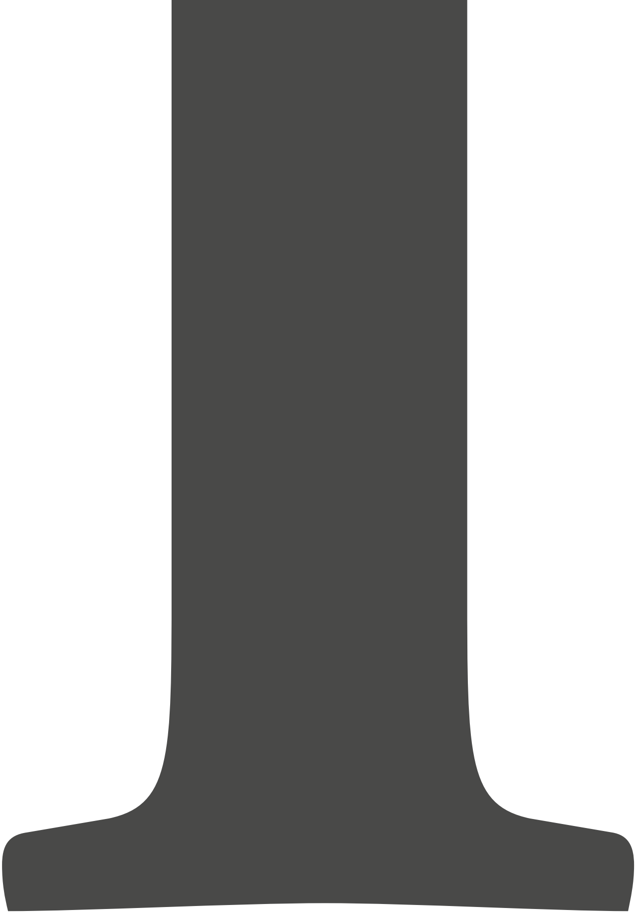


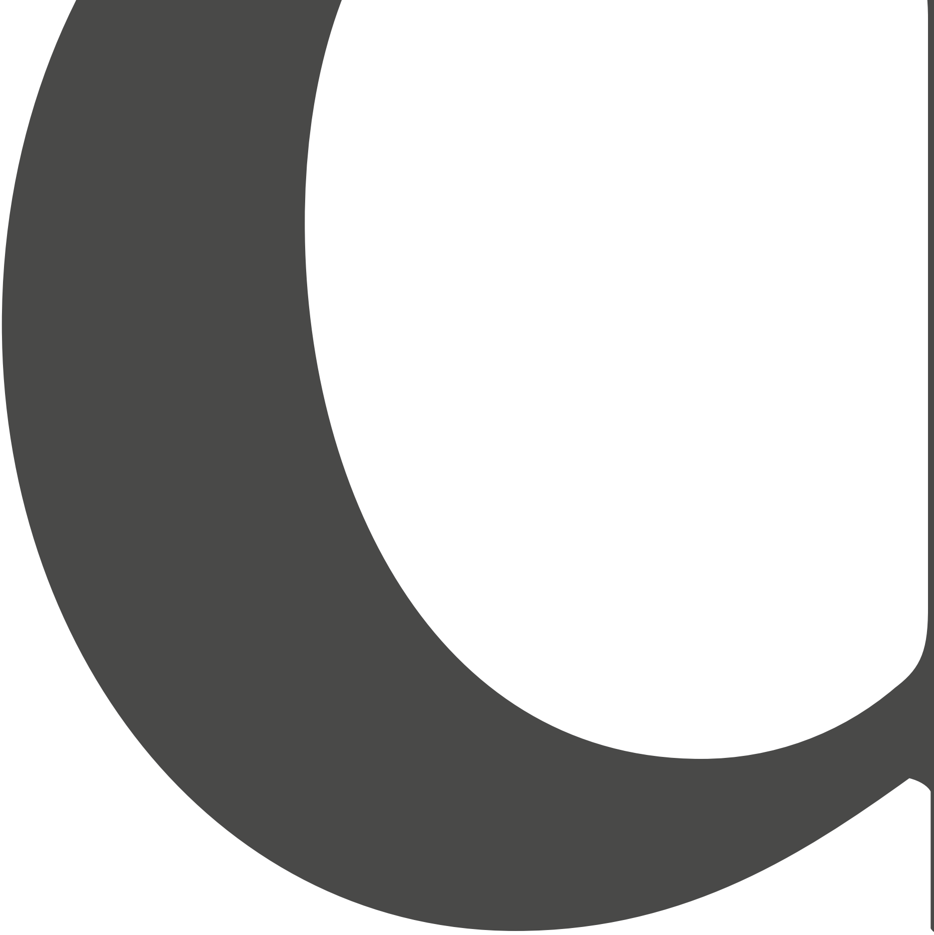
V

y

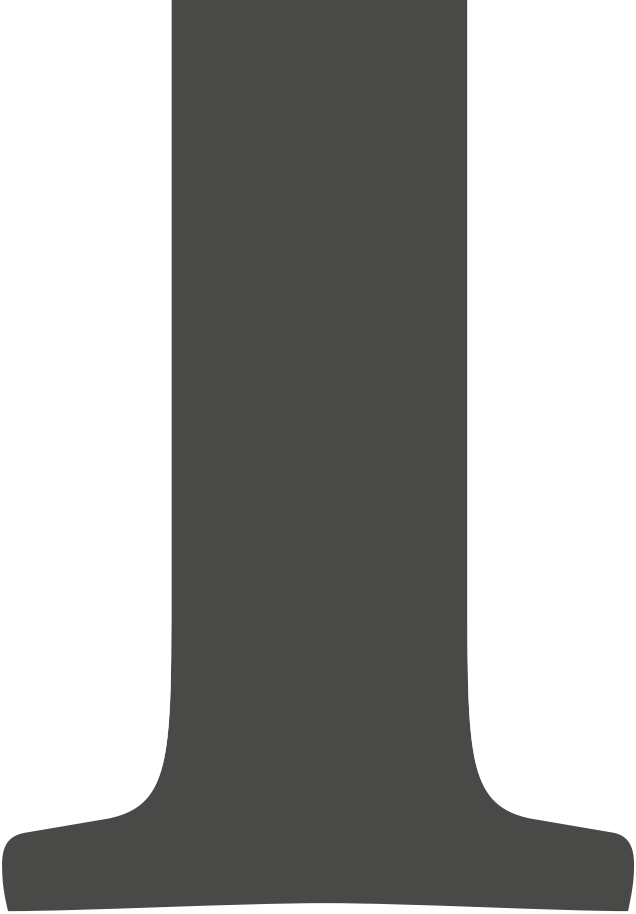


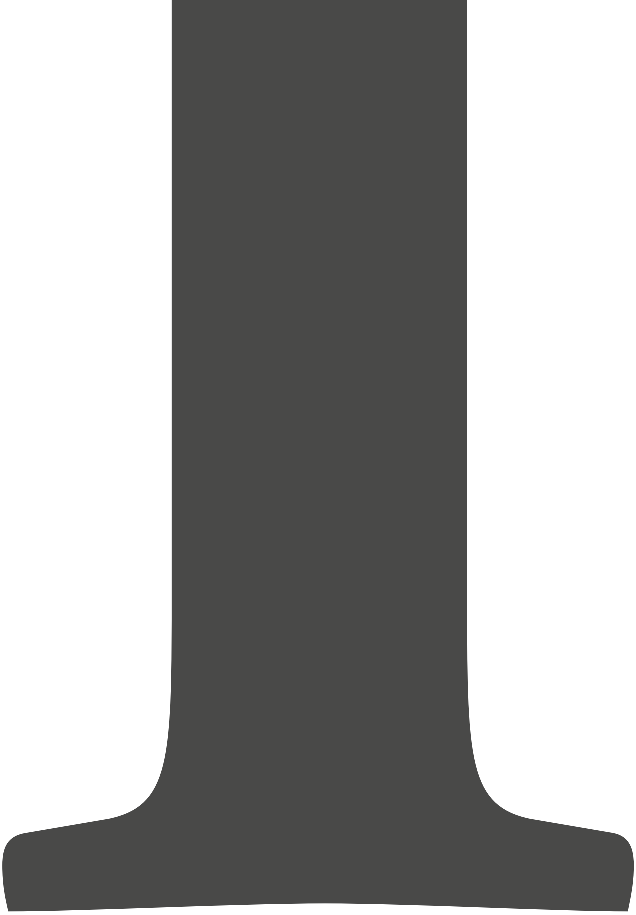


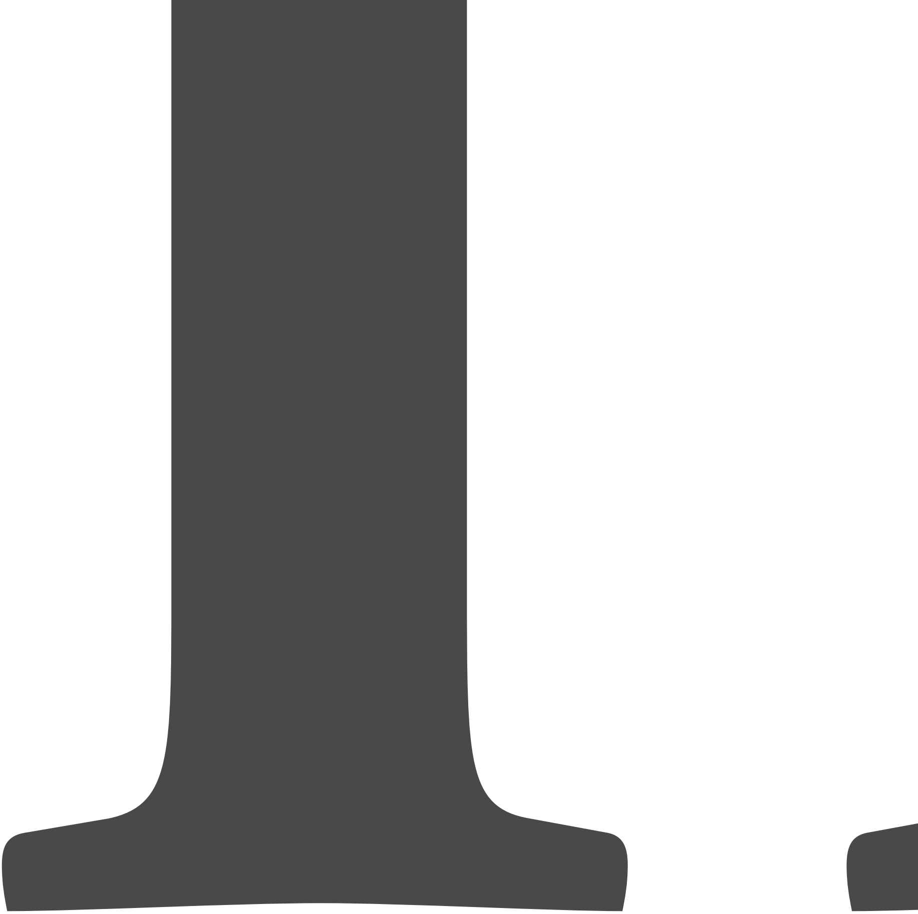


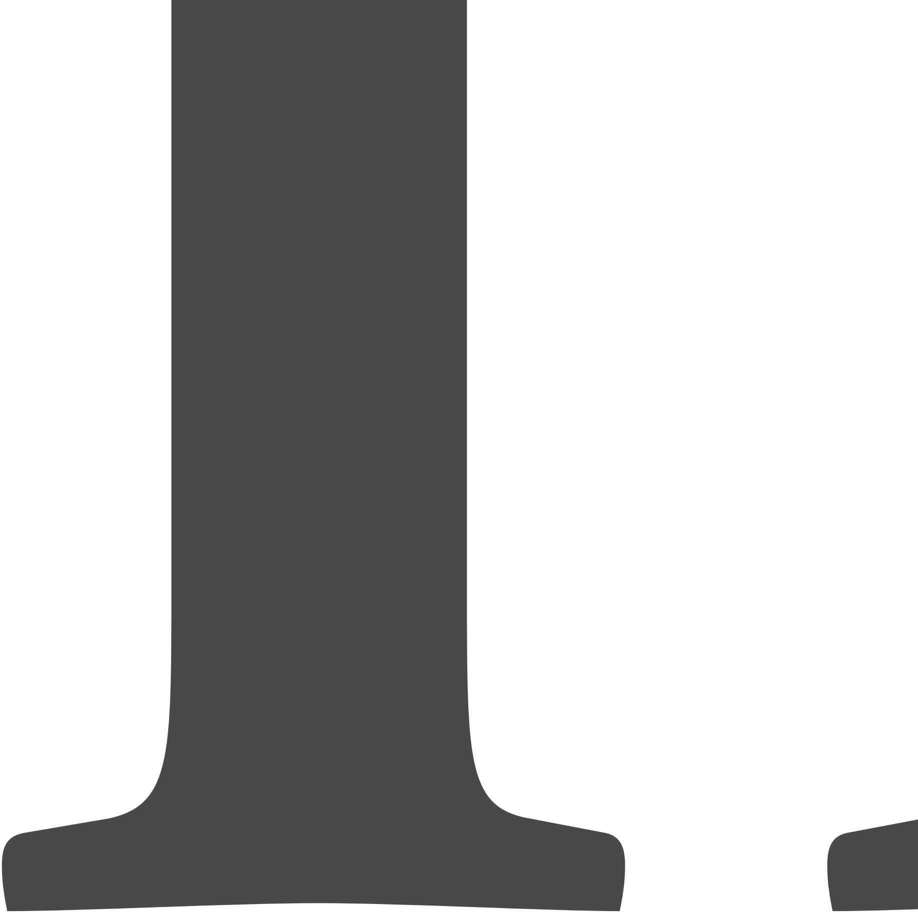


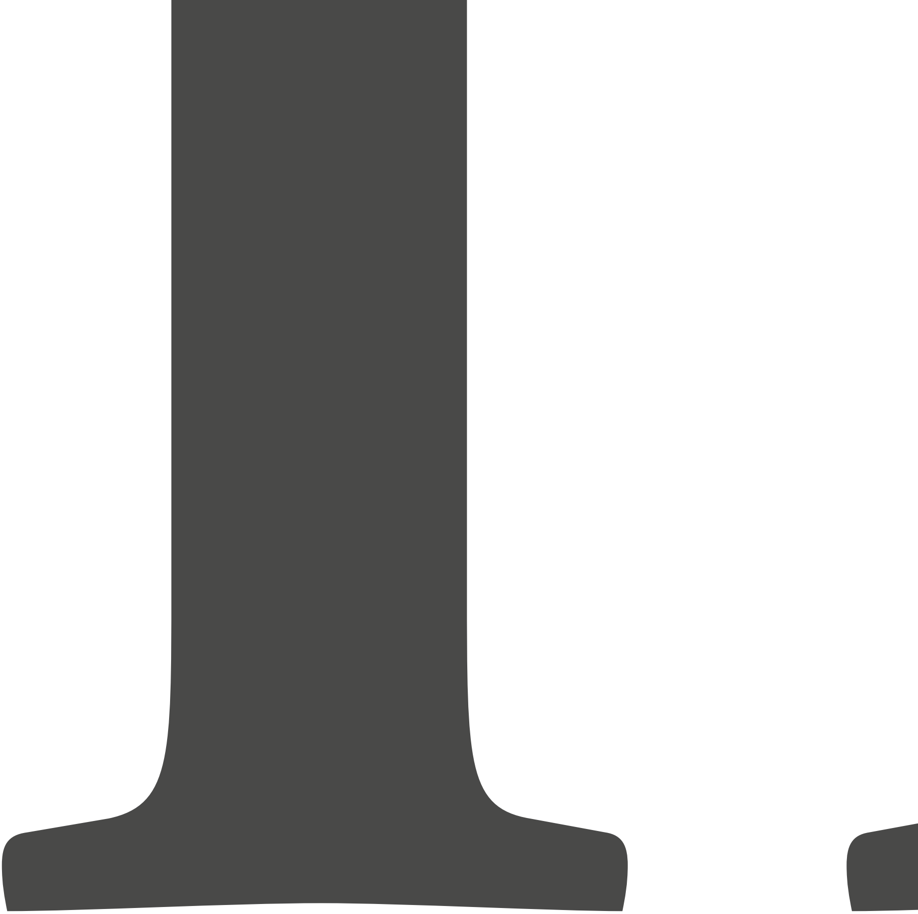
g

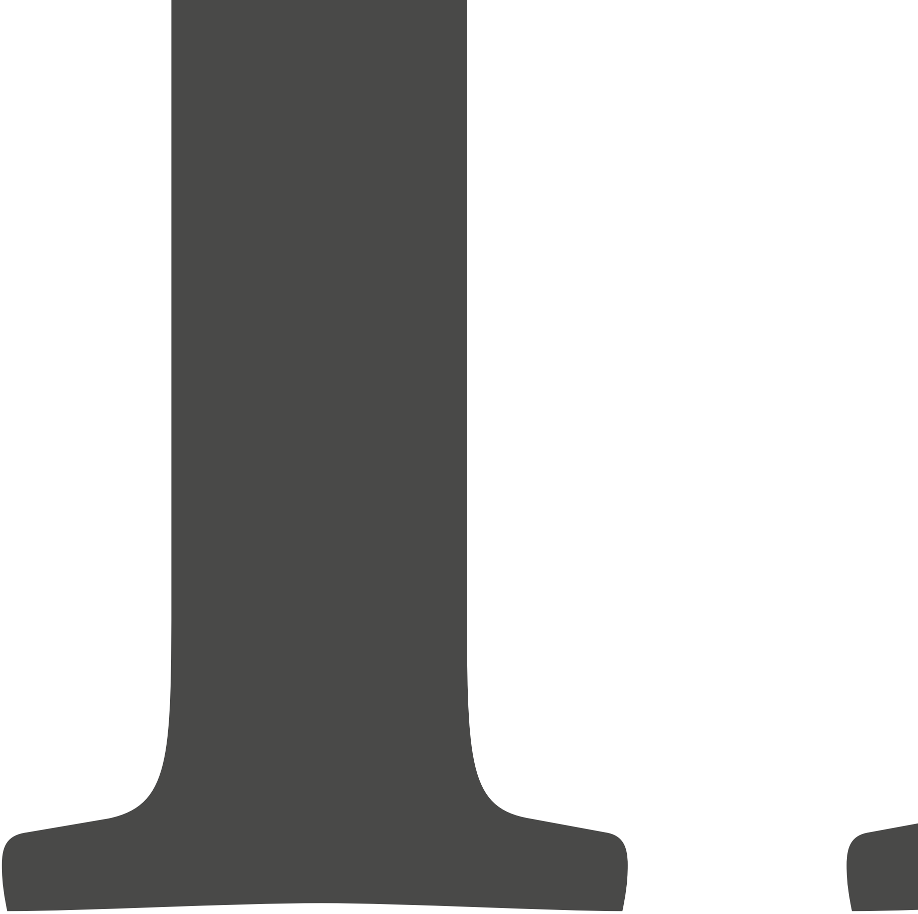


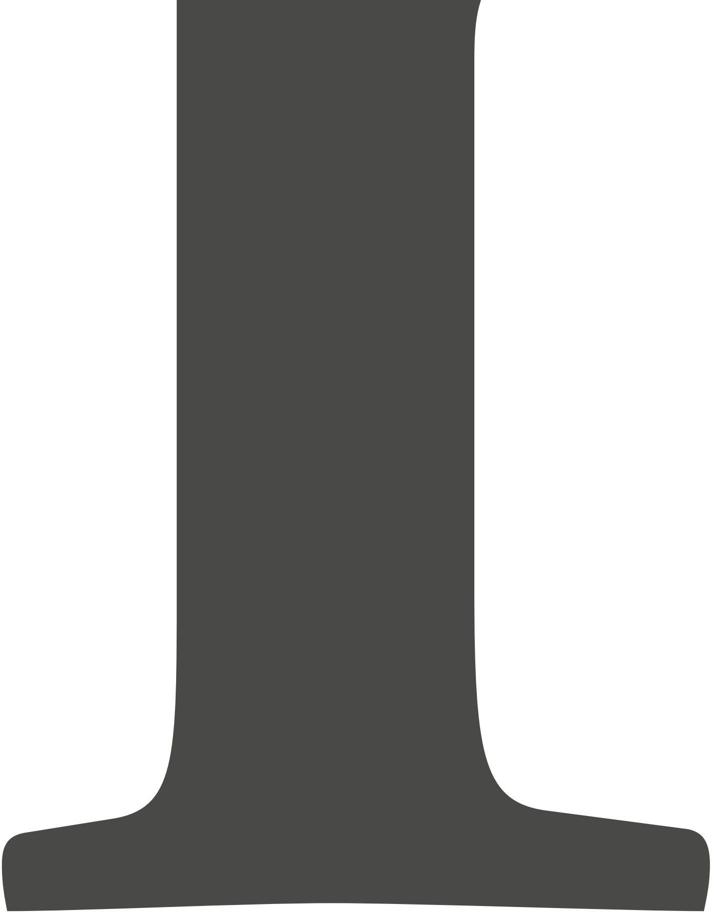


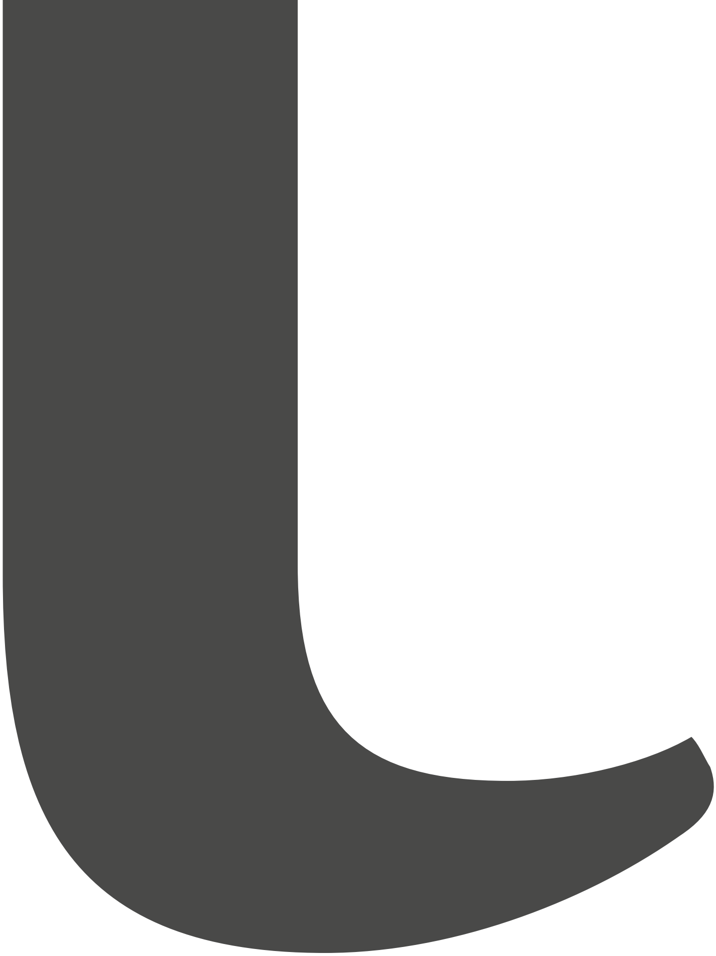


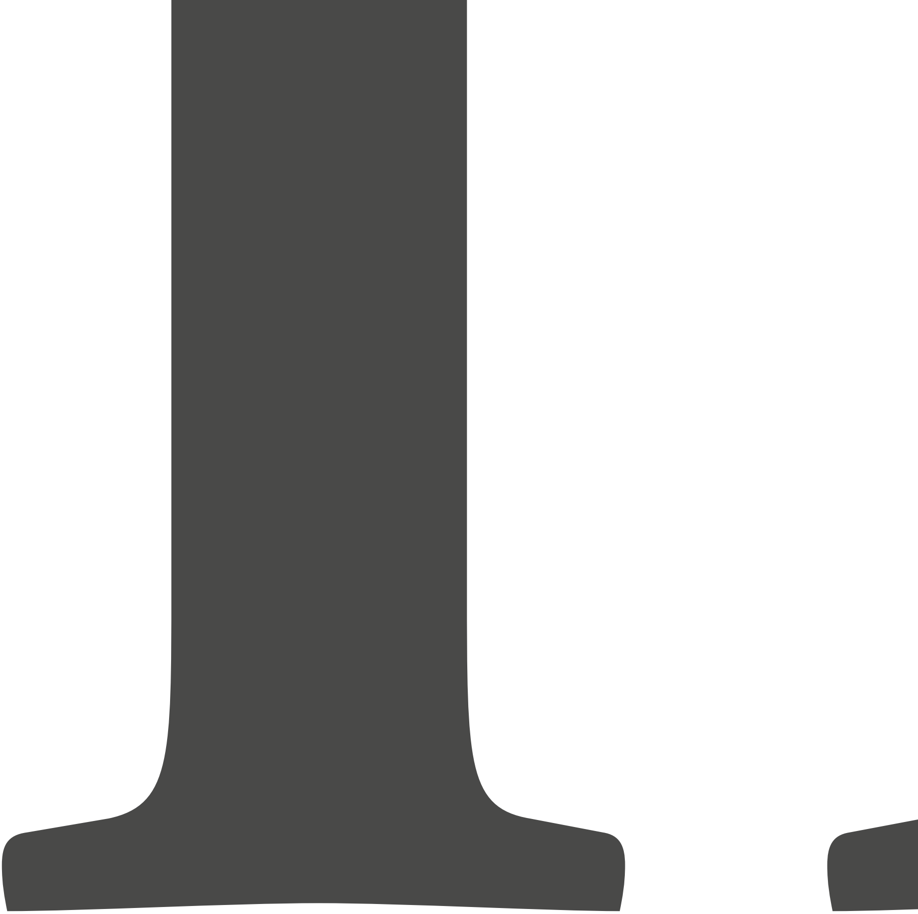


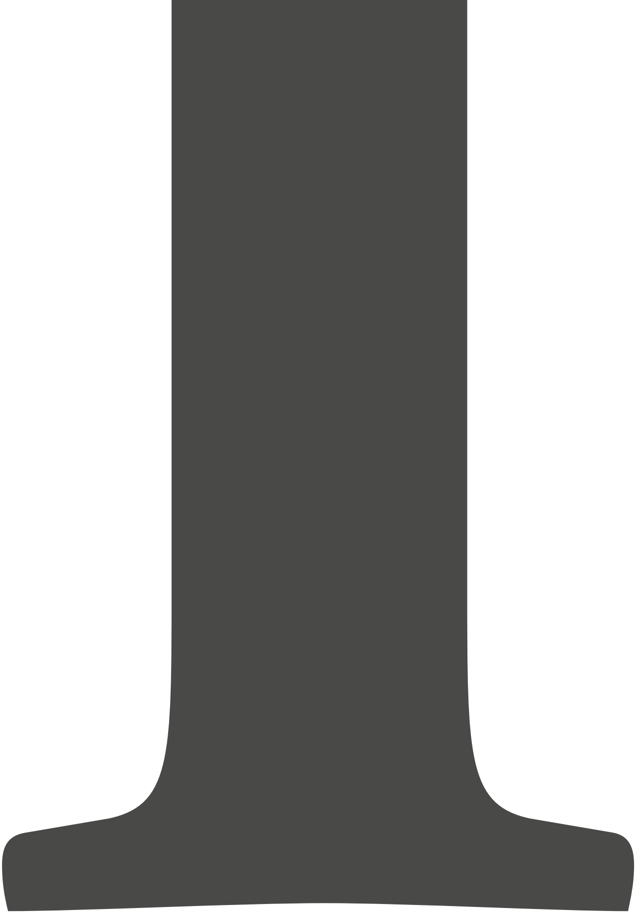


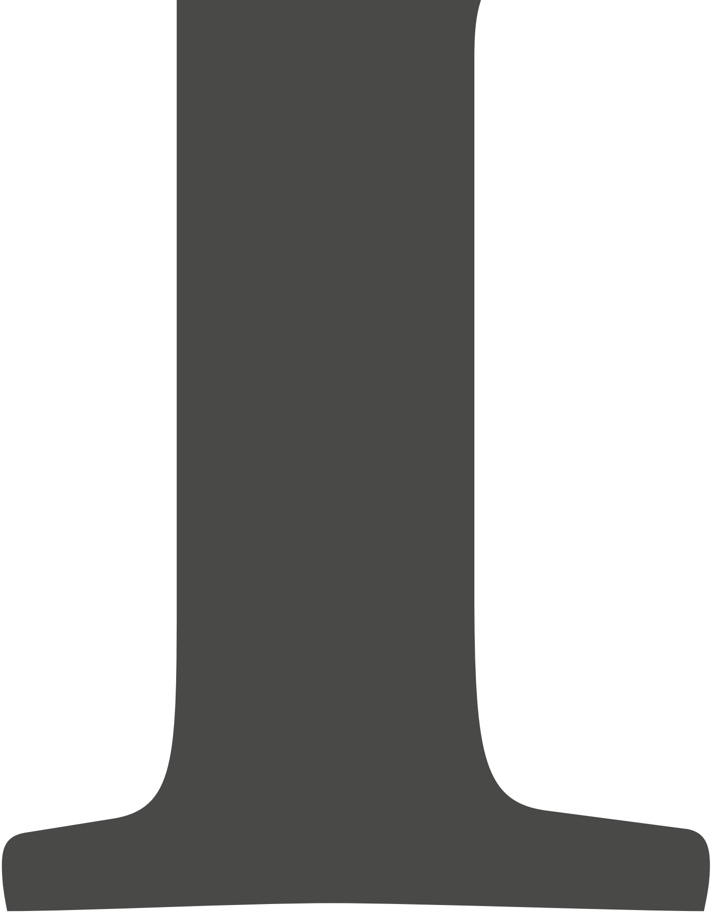


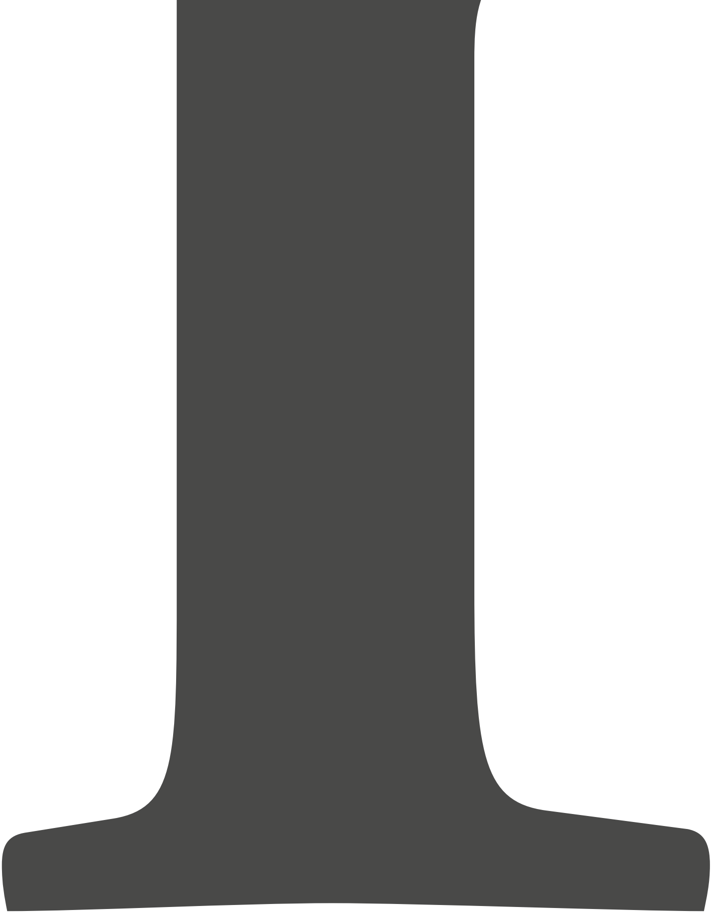


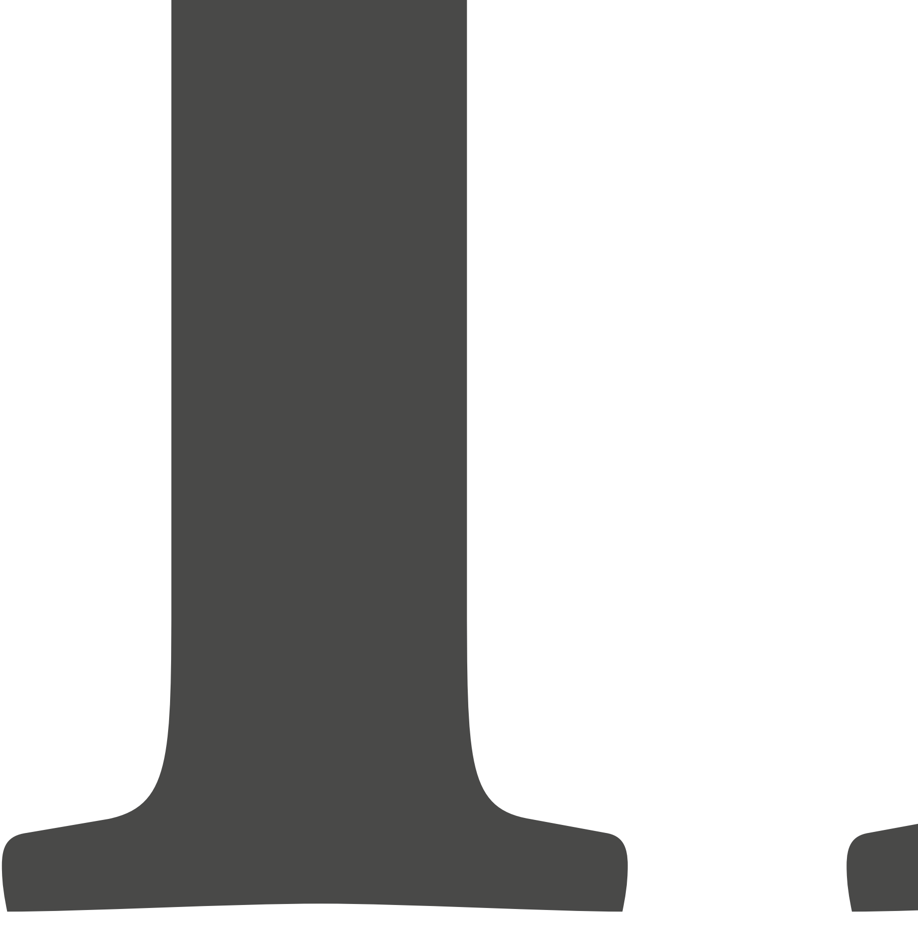


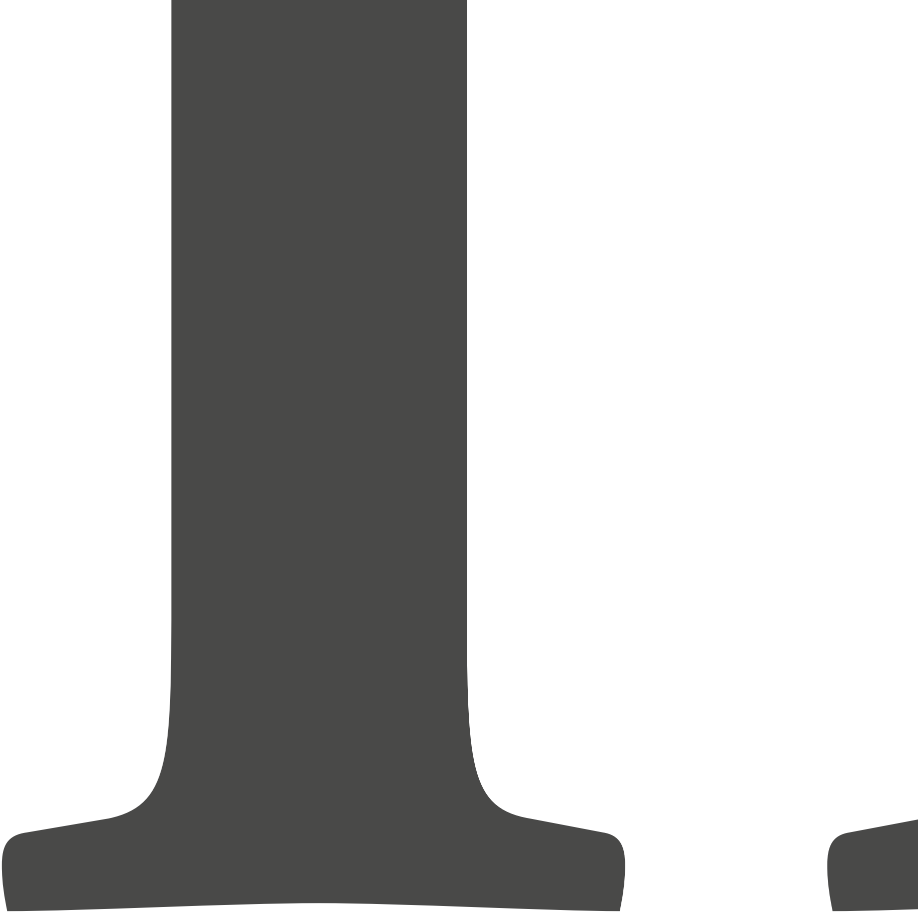


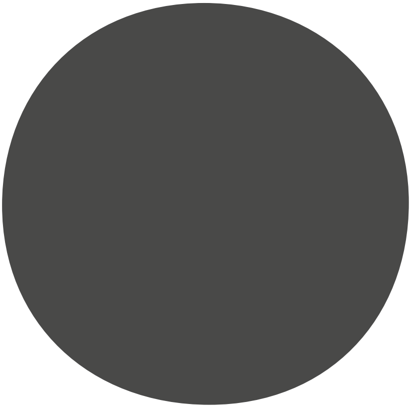


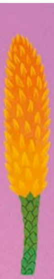


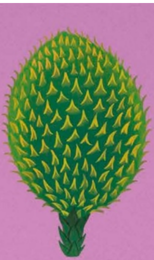












Male and female

Male cones, also called pollen cones, are small, soft, and loaded with pollen. Female cones have woody scales and are much larger. They are often called seed cones, because when pollinated, they slowly swell with seeds.

T

C

C

a

th

a

T

p

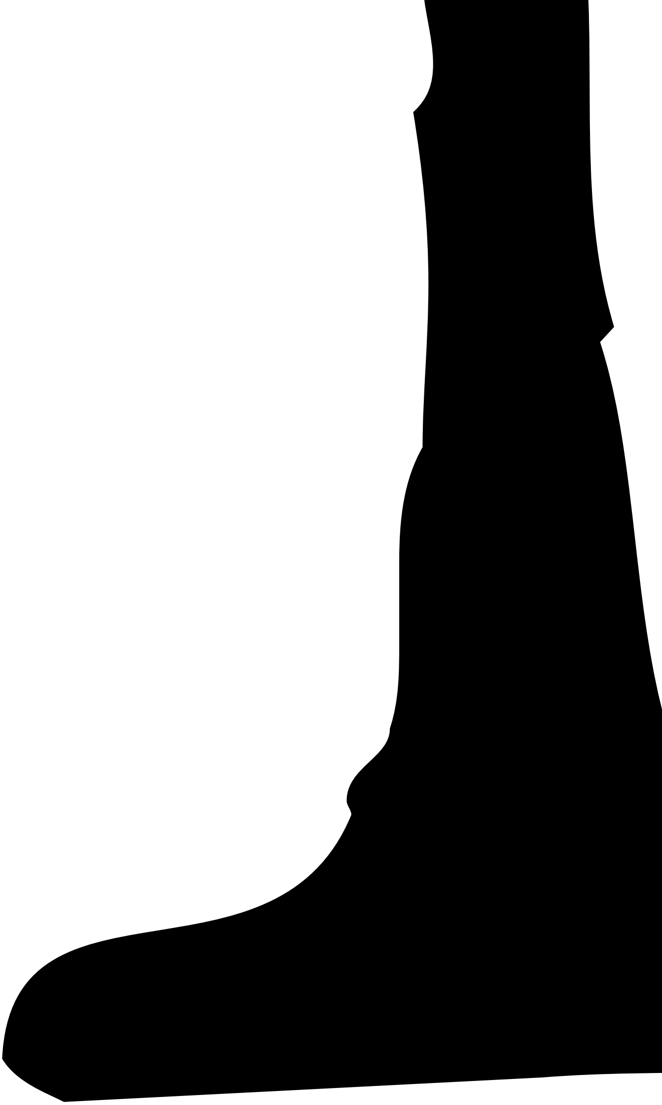
o

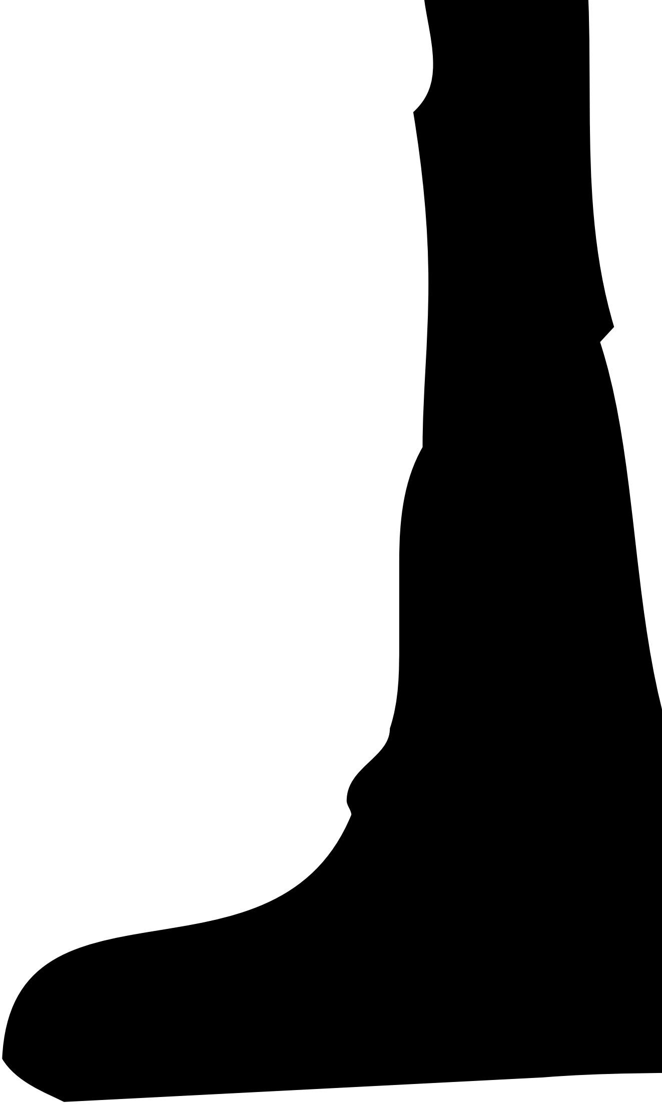
b

li

u

M





IV

p

T

m

b

pi

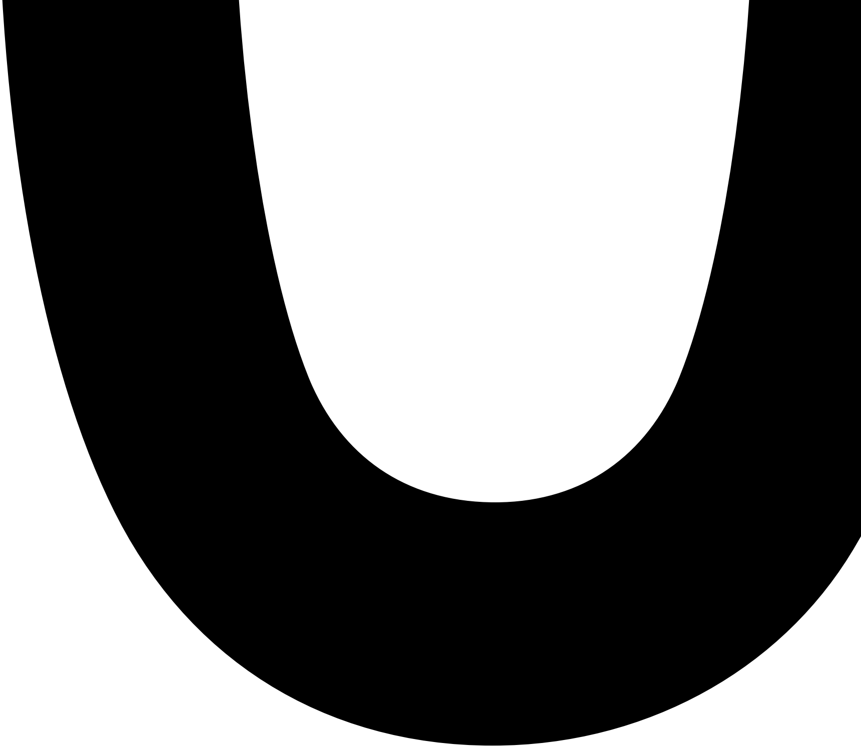
A

ye

C

S

Cones



T

C

b

A

le

it

T

fr

M

C

th

f

U

fe

fl

W

ju

C

fe

S

C

in

th

T

m

a

in

M

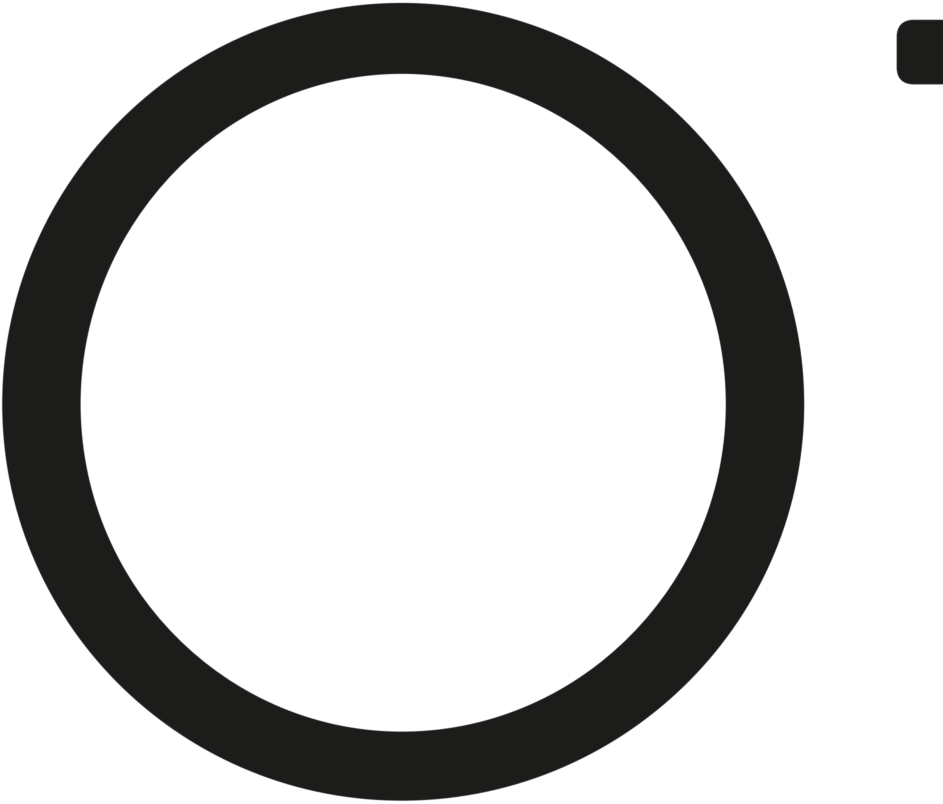
T

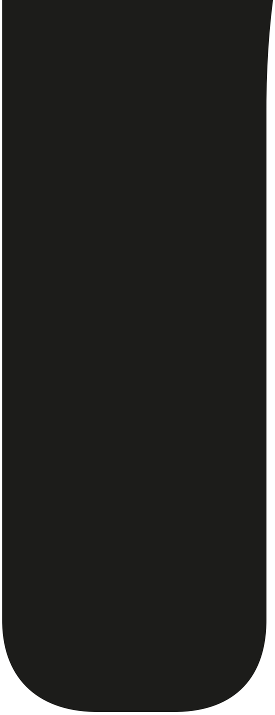
A

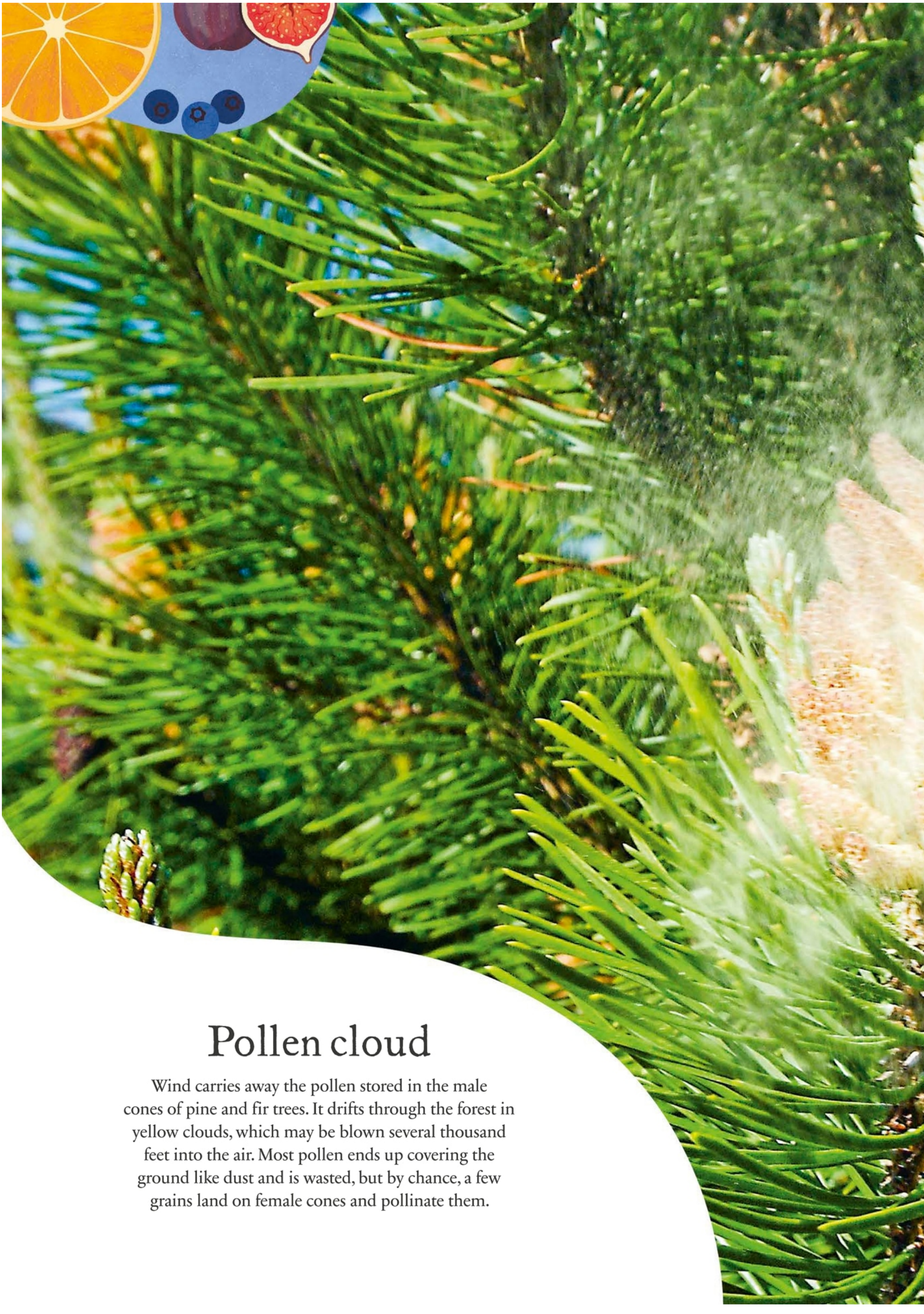
p

S

f

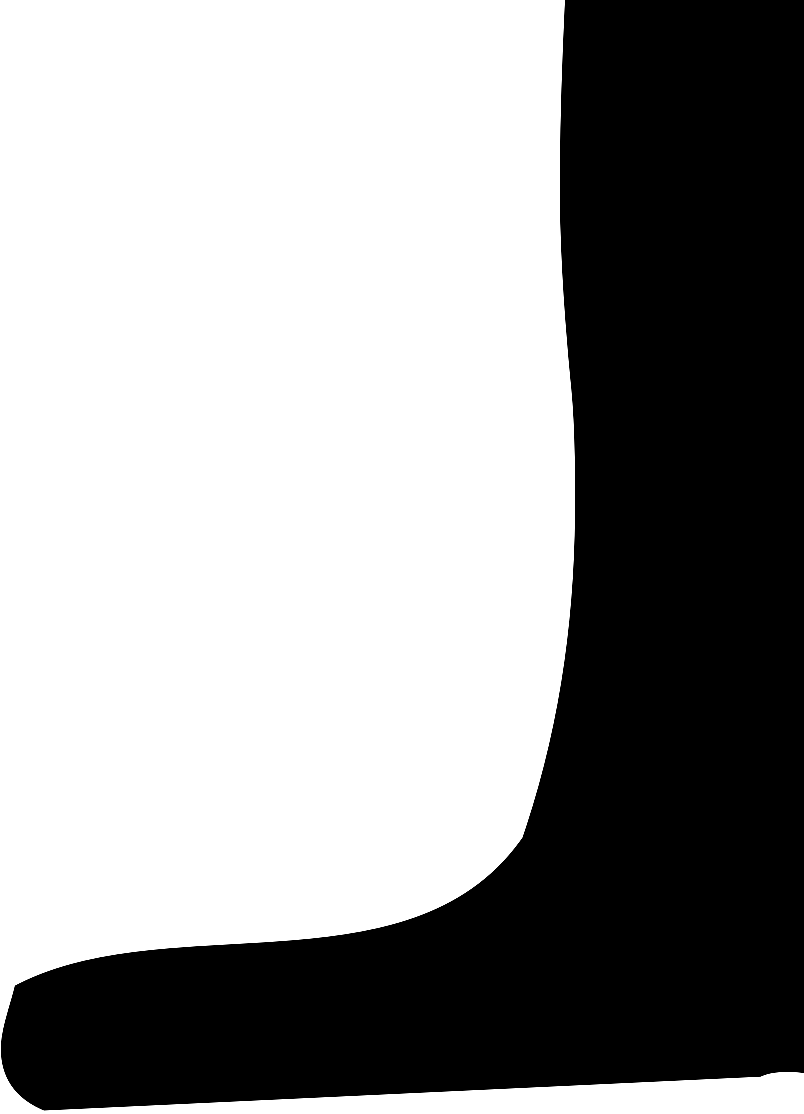


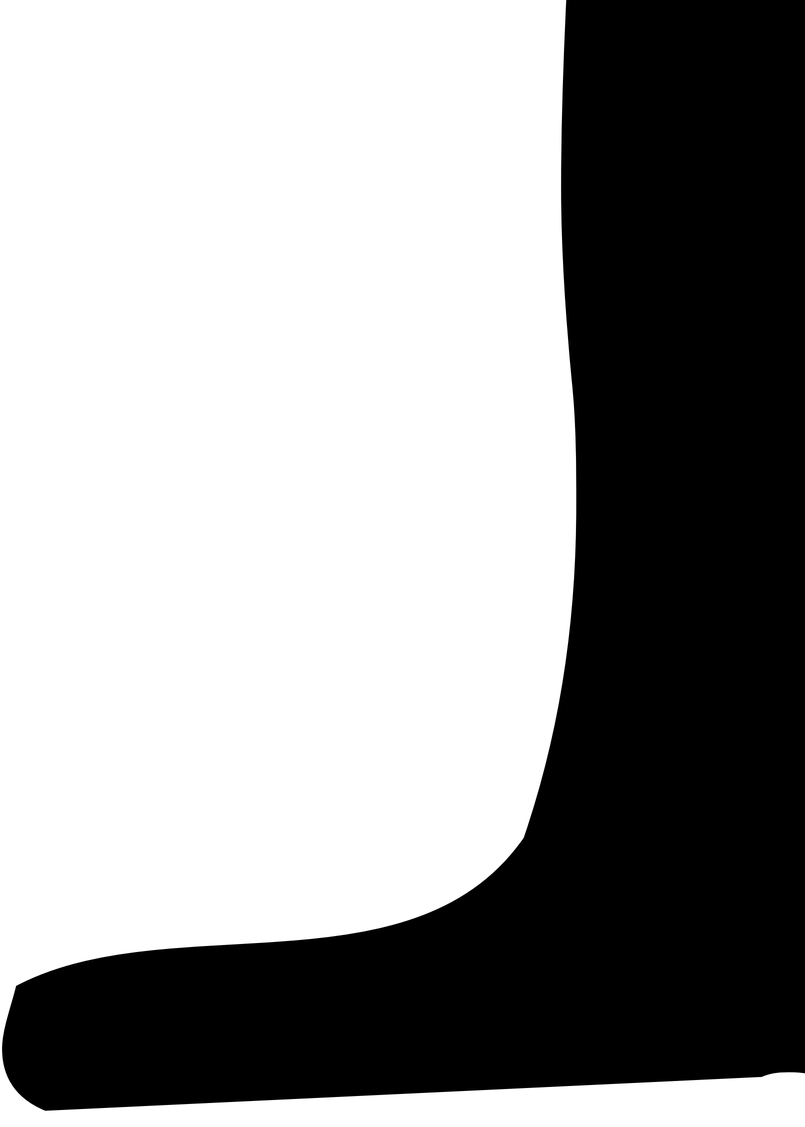


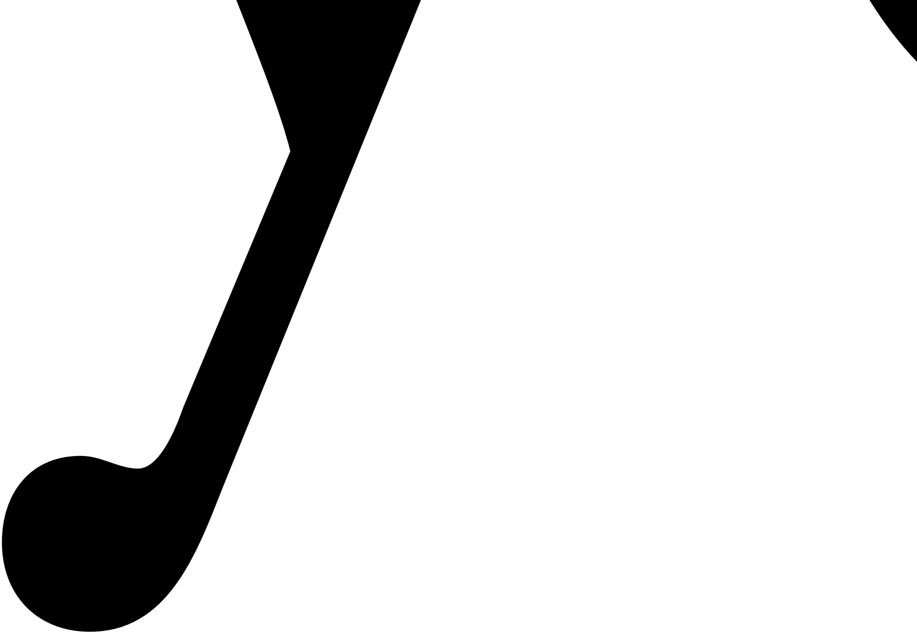


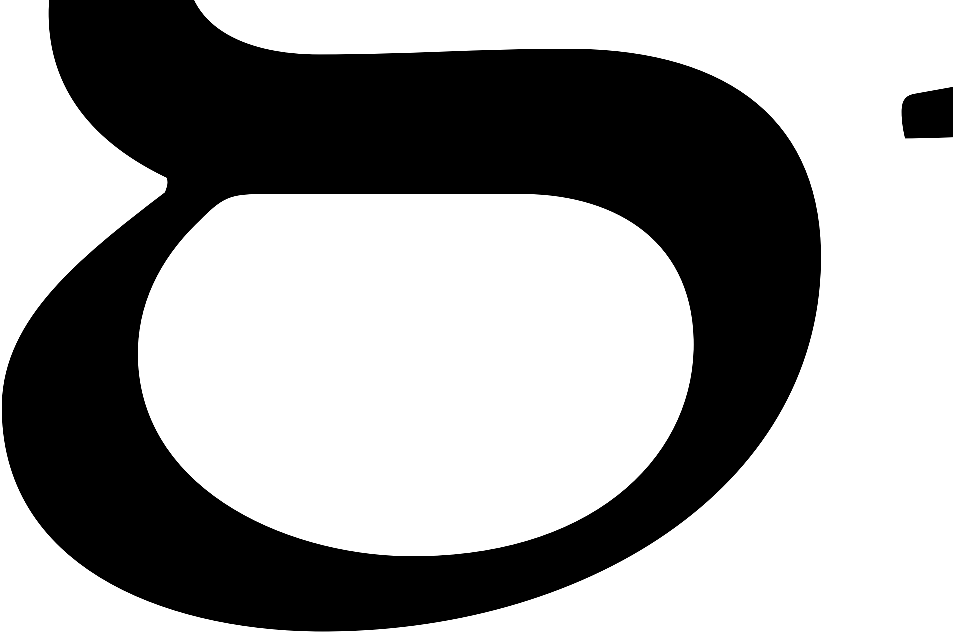
Pollen cloud

Wind carries away the pollen stored in the male cones of pine and fir trees. It drifts through the forest in yellow clouds, which may be blown several thousand feet into the air. Most pollen ends up covering the ground like dust and is wasted, but by chance, a few grains land on female cones and pollinate them.



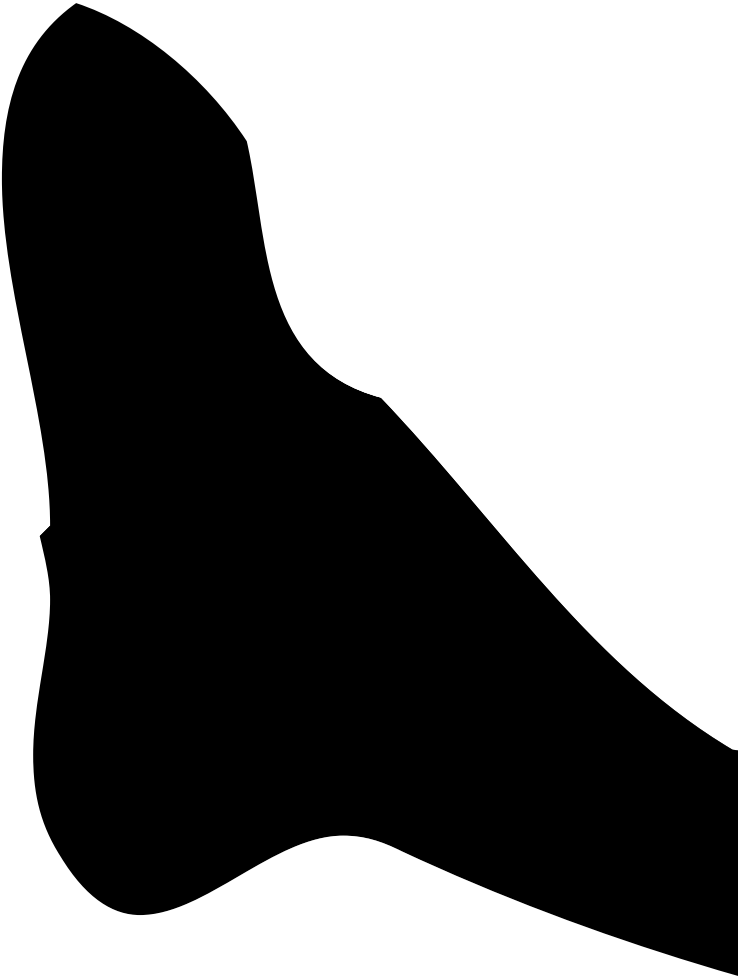


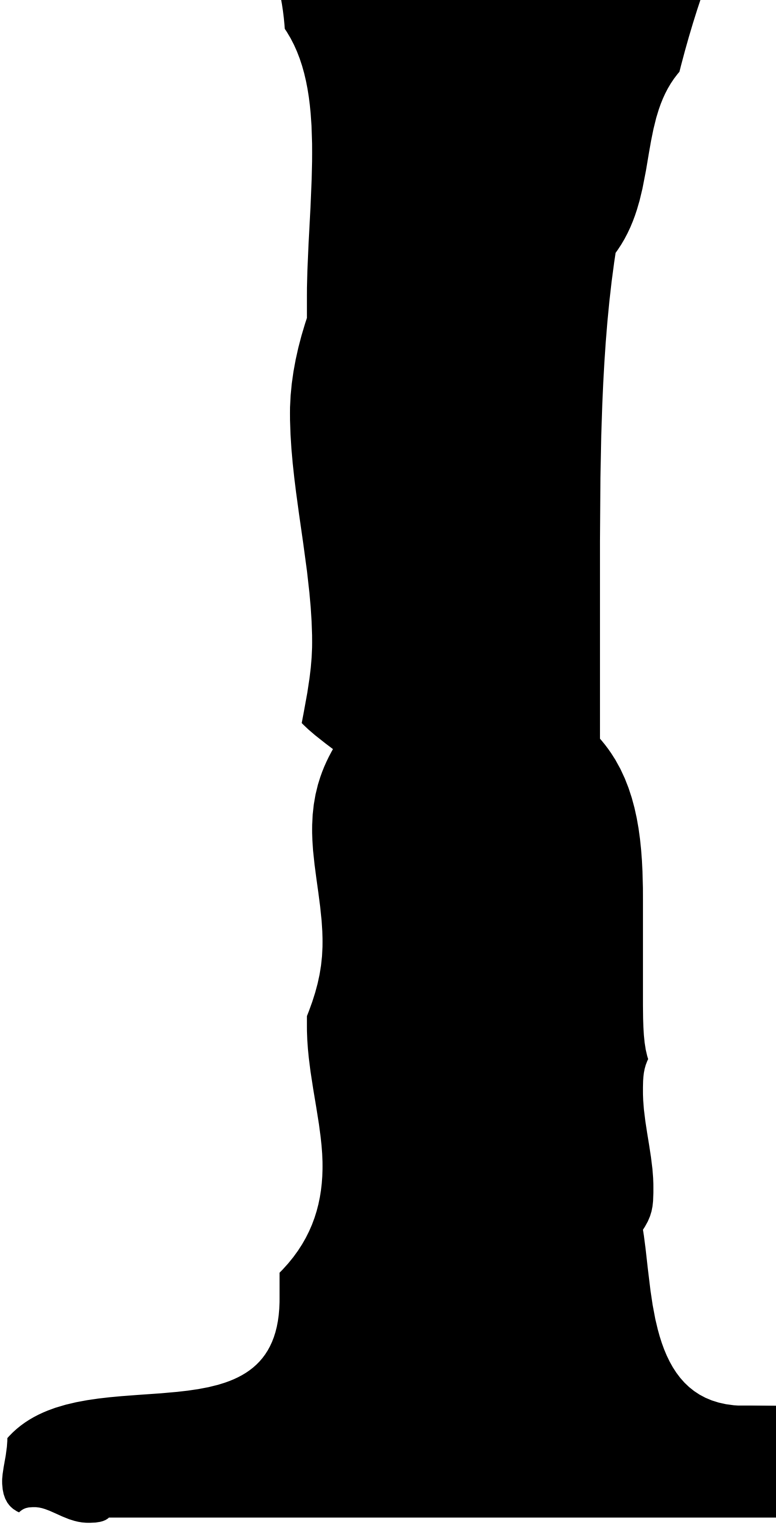


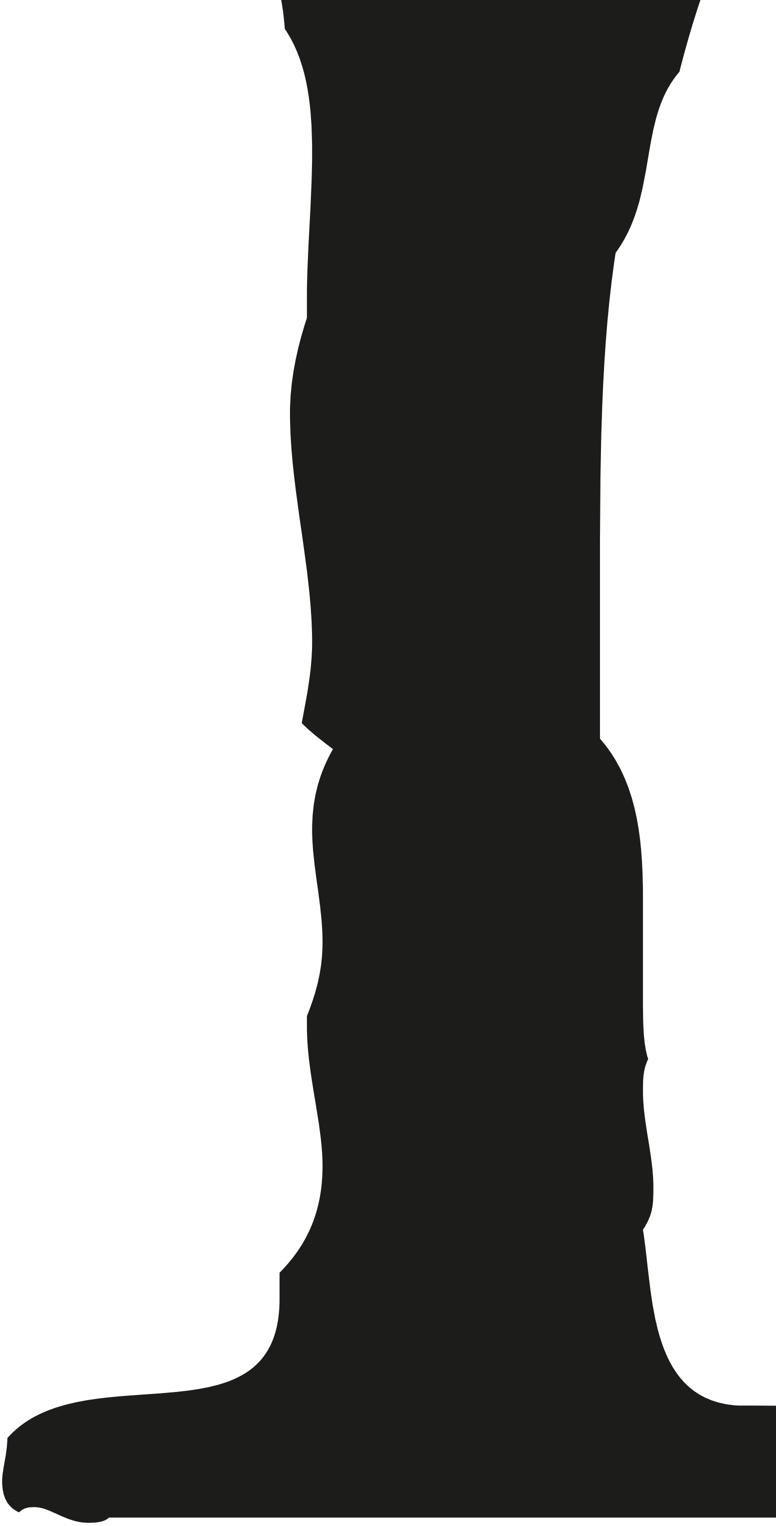


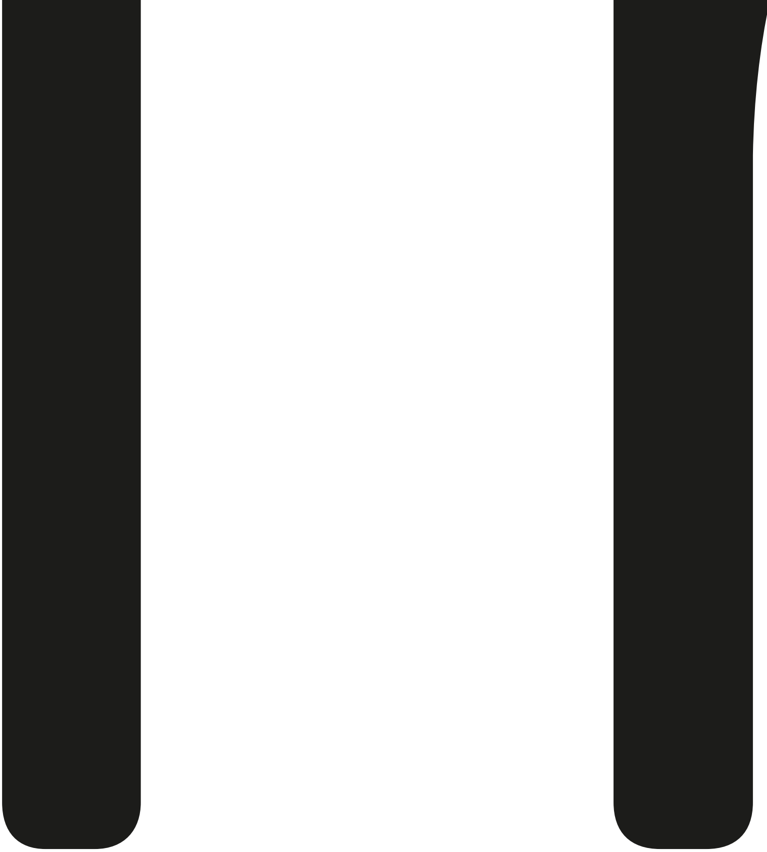
g

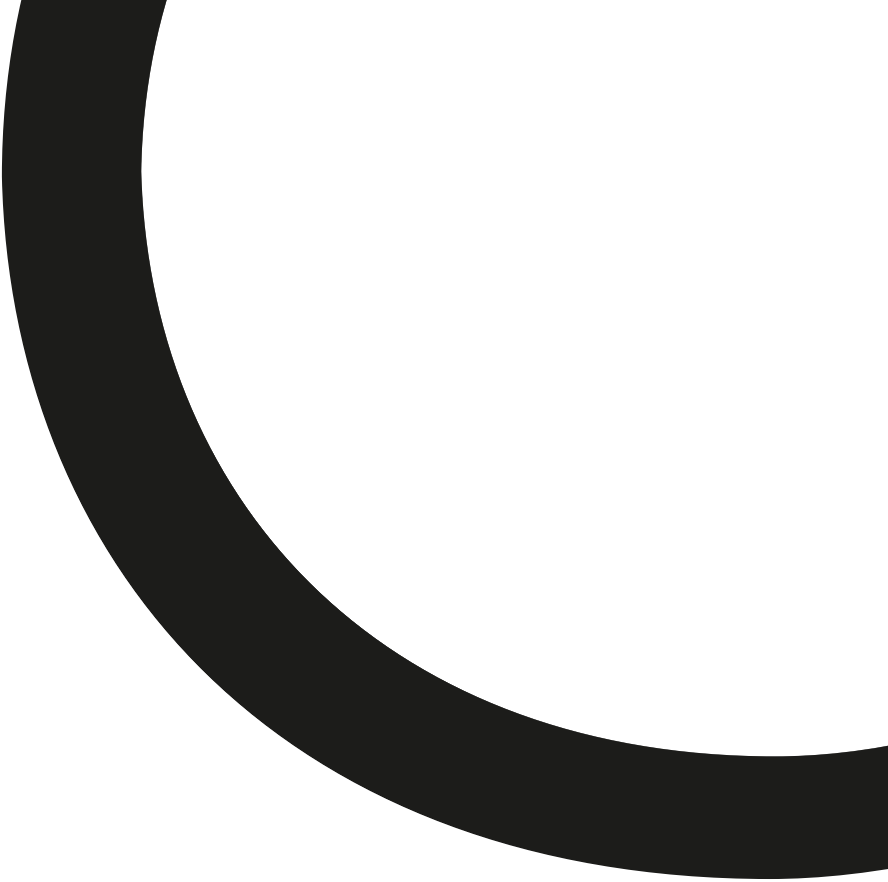
Seeds and nuts

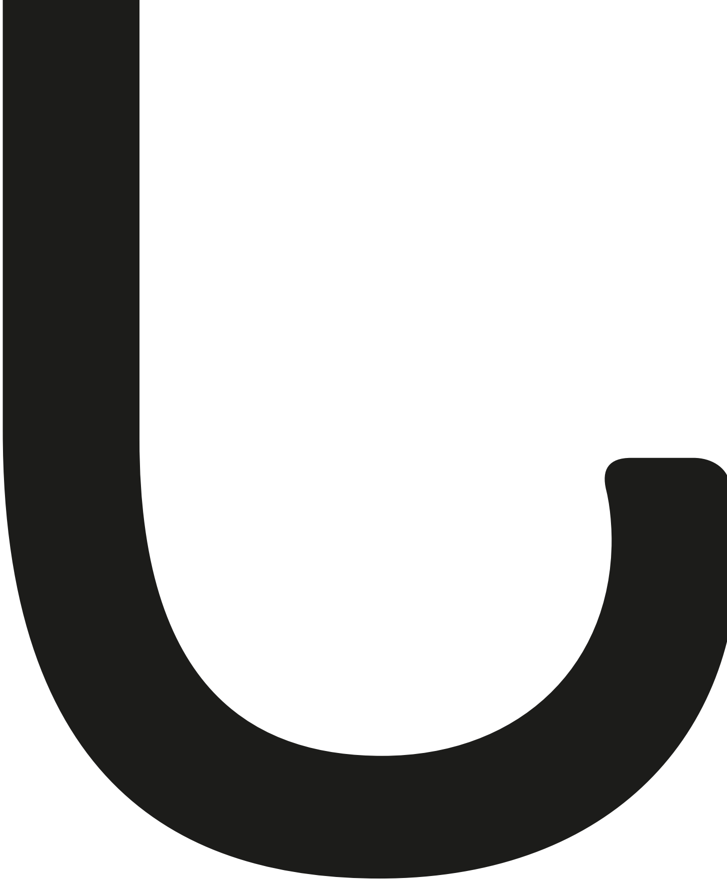


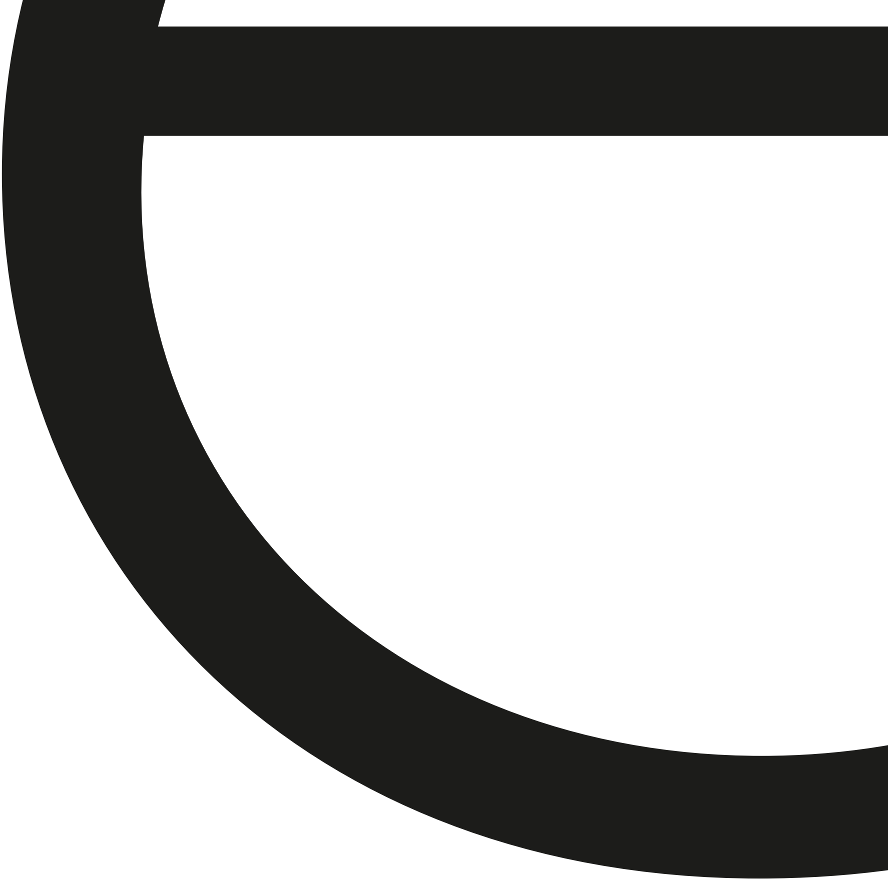




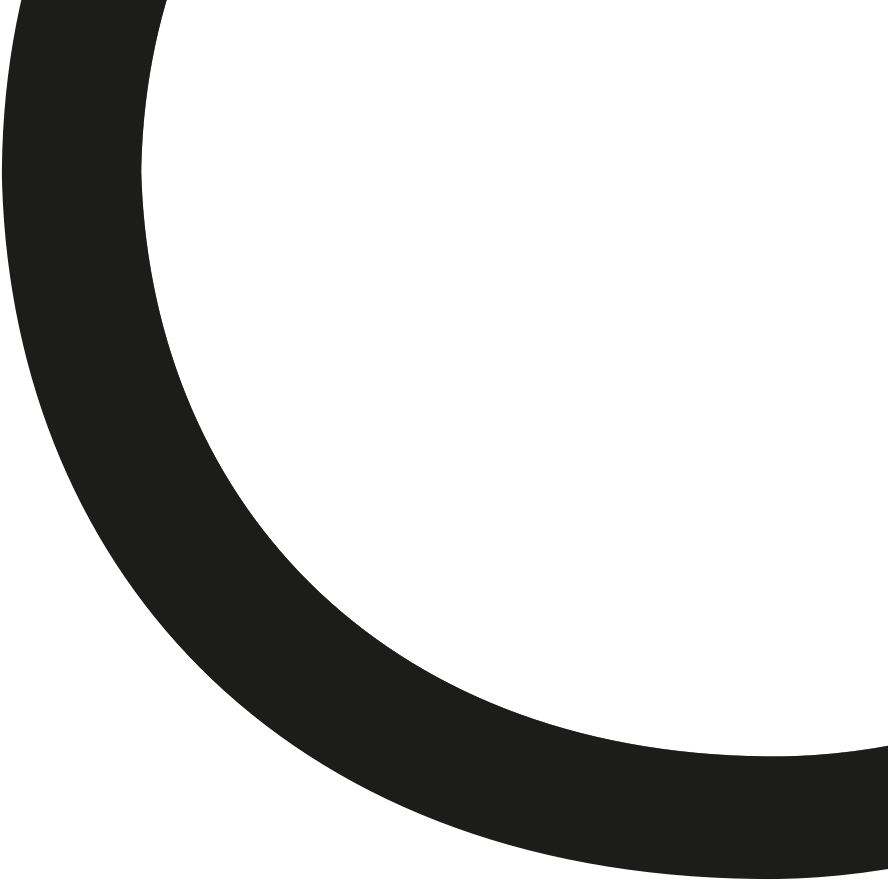


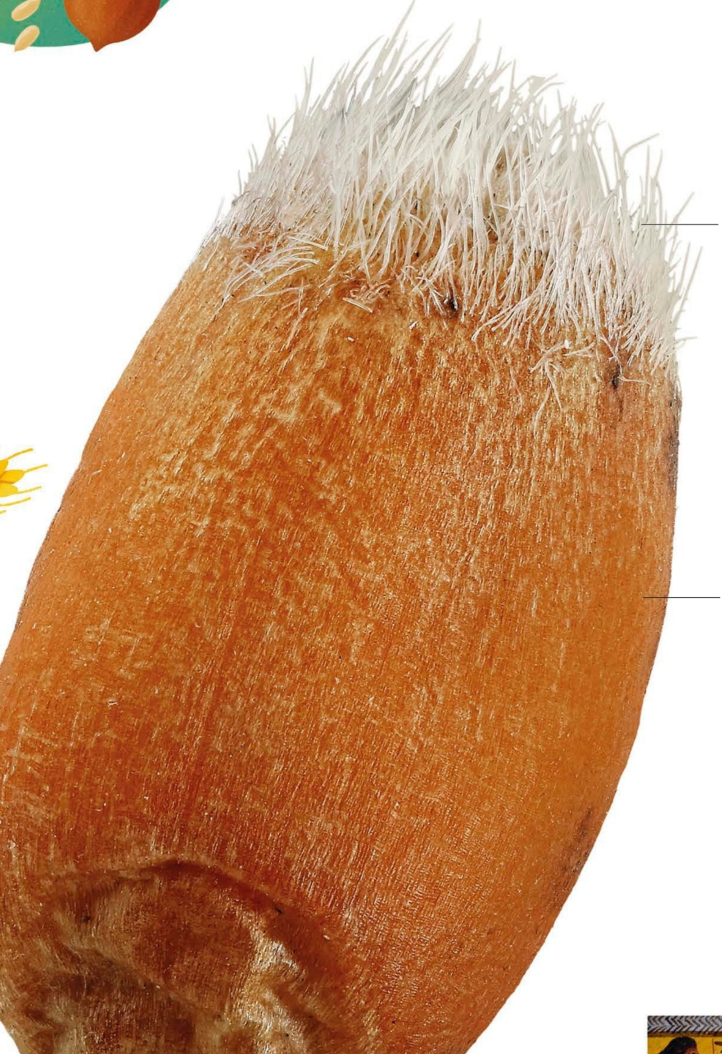






V





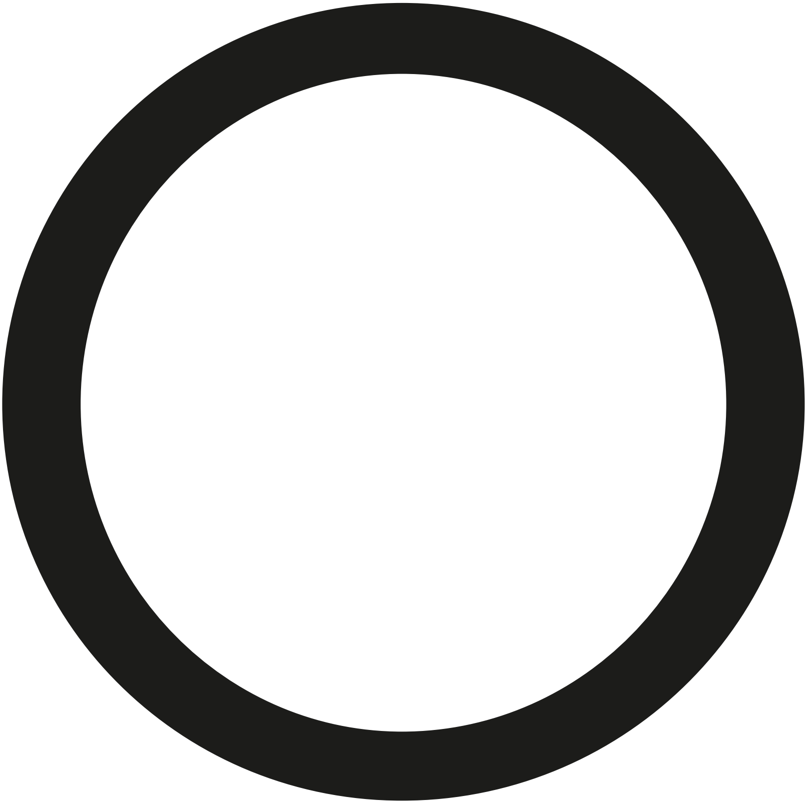
T

f

C

fr

e



Th

h

C

M

g

a

(5

B

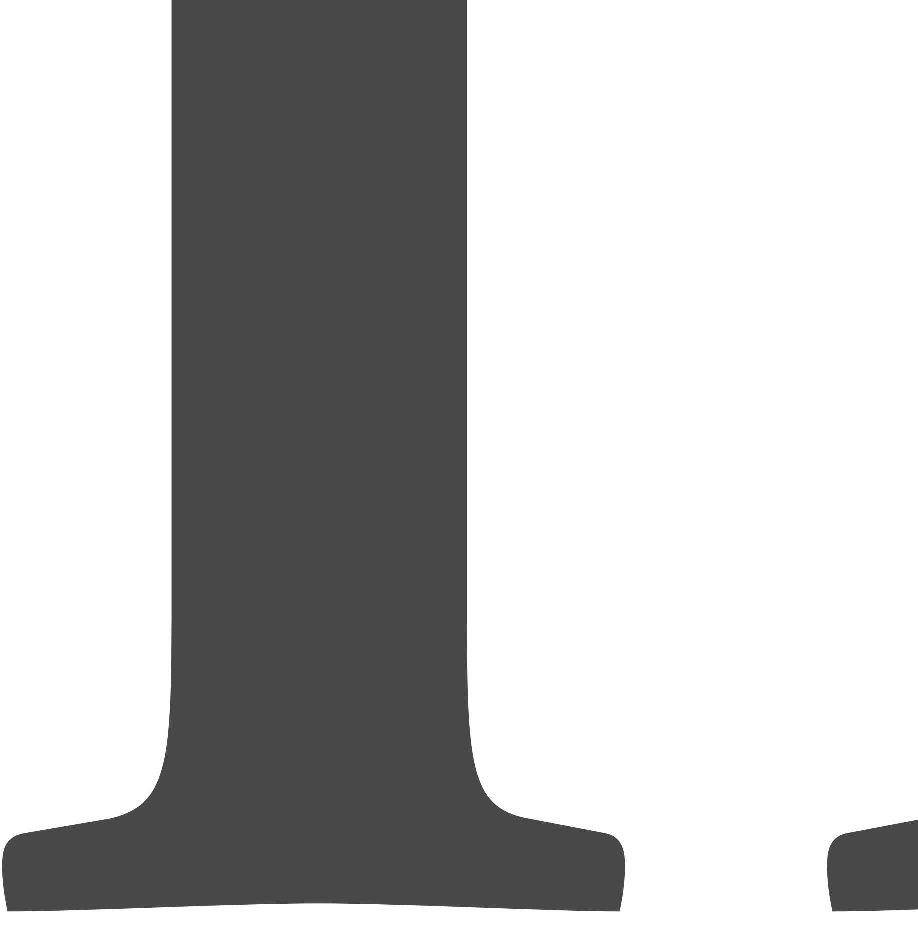
“V

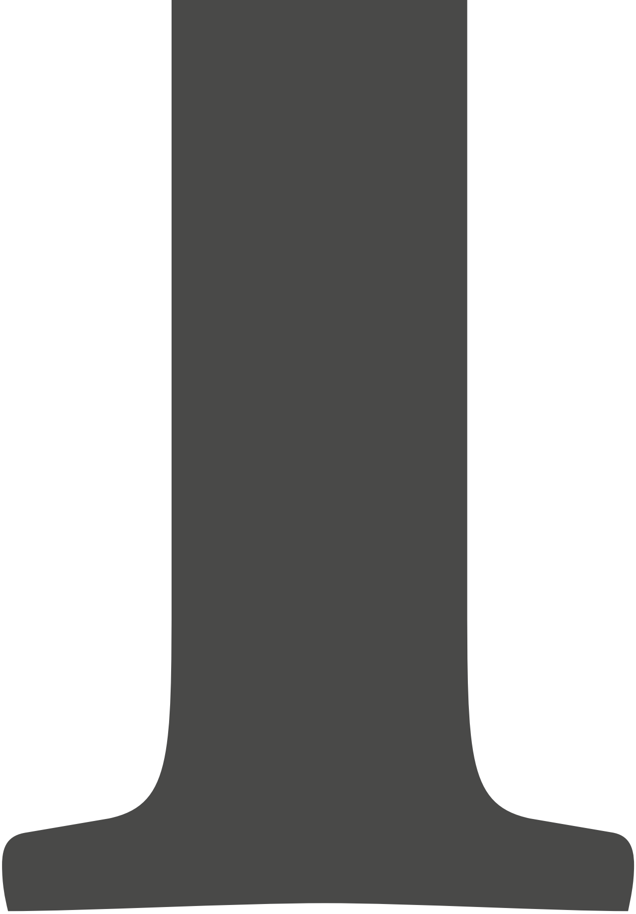
fr

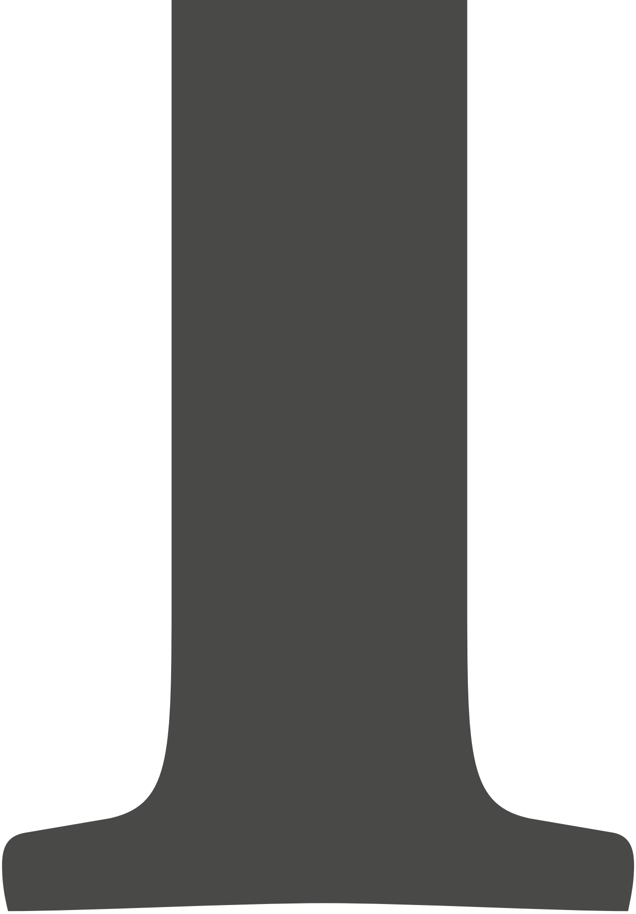
se

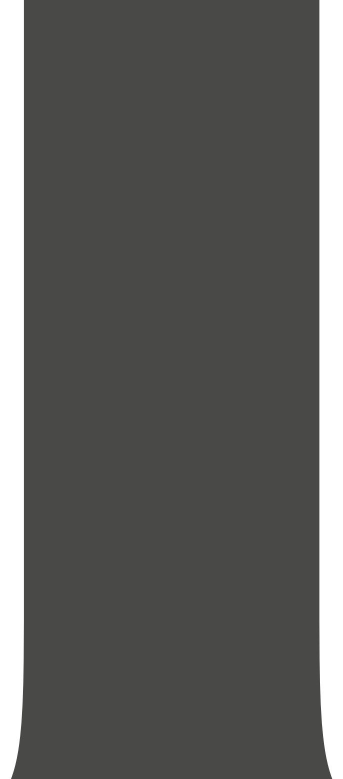
g

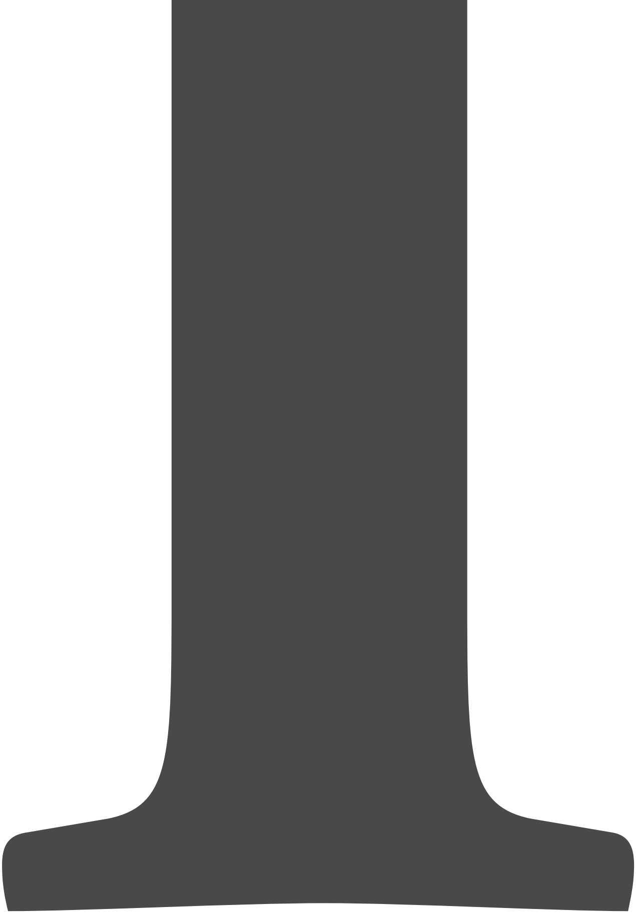
m

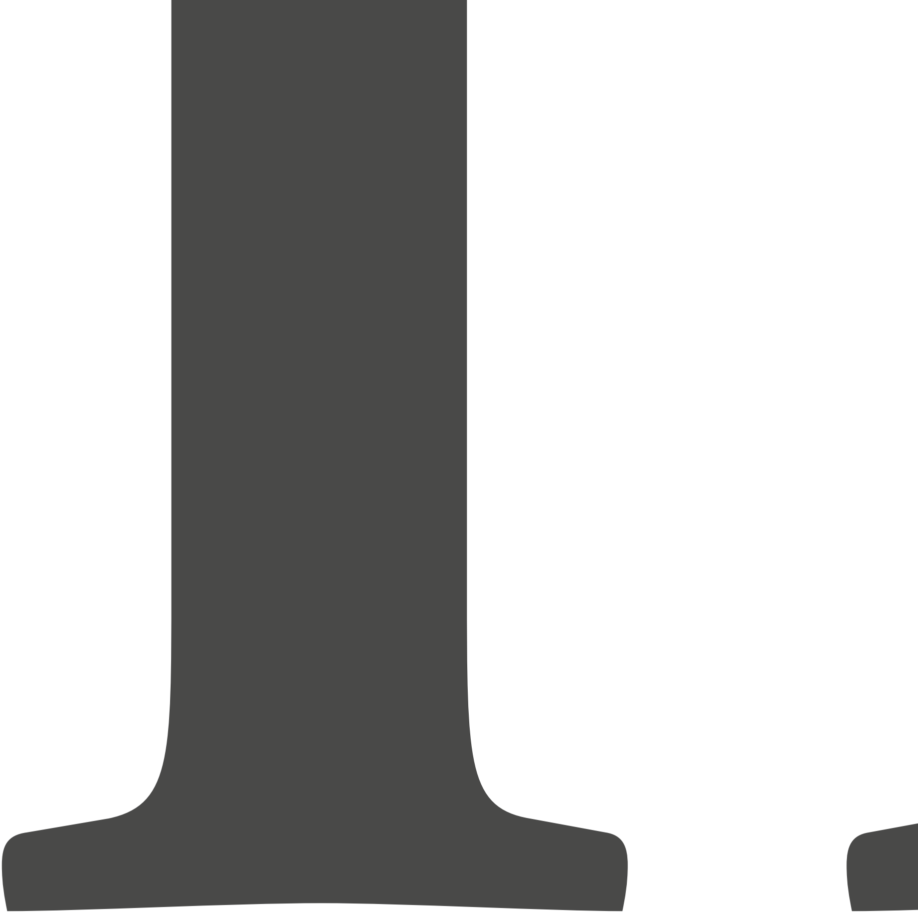


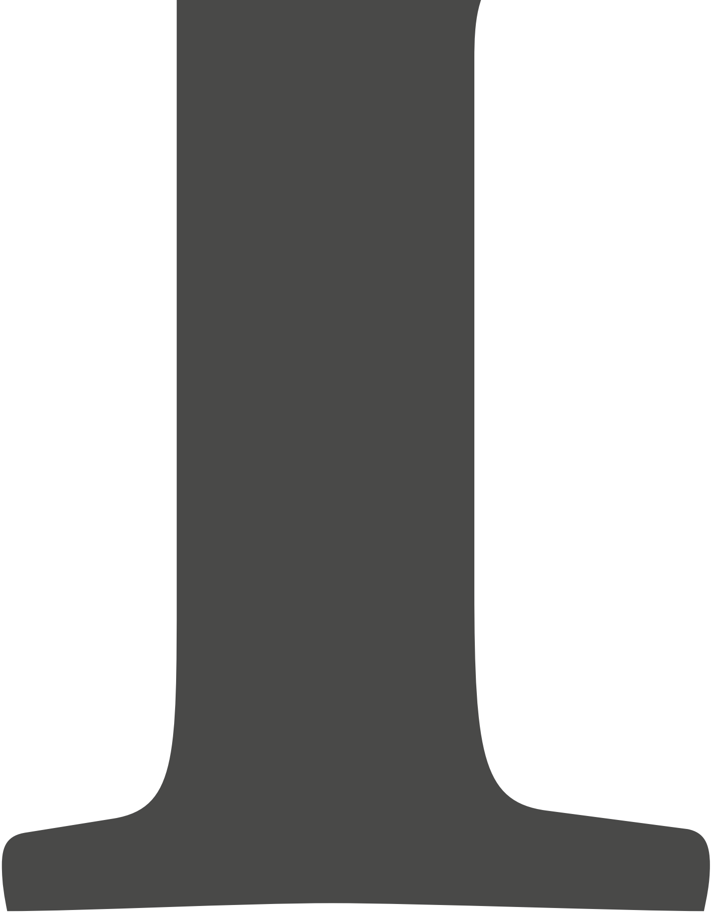


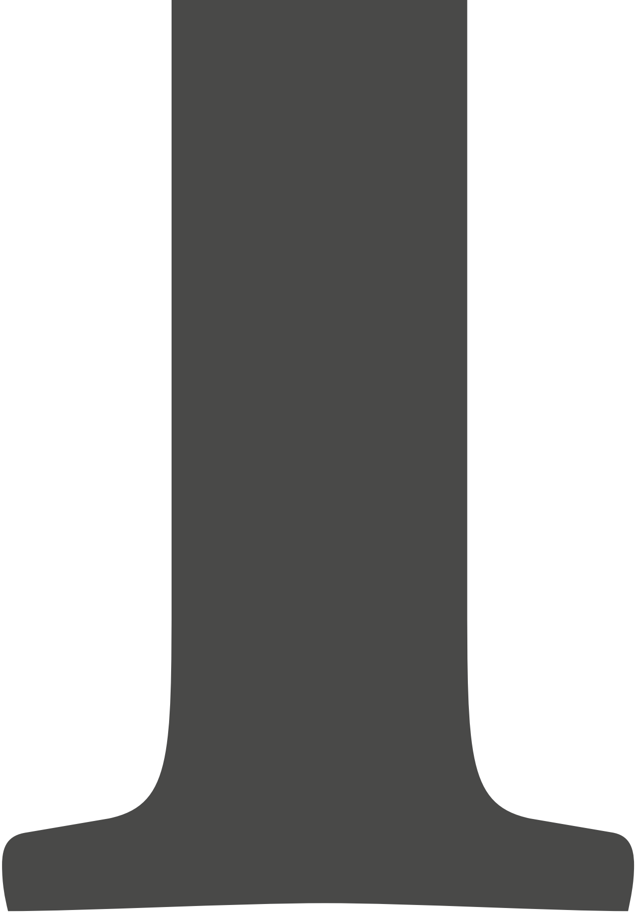


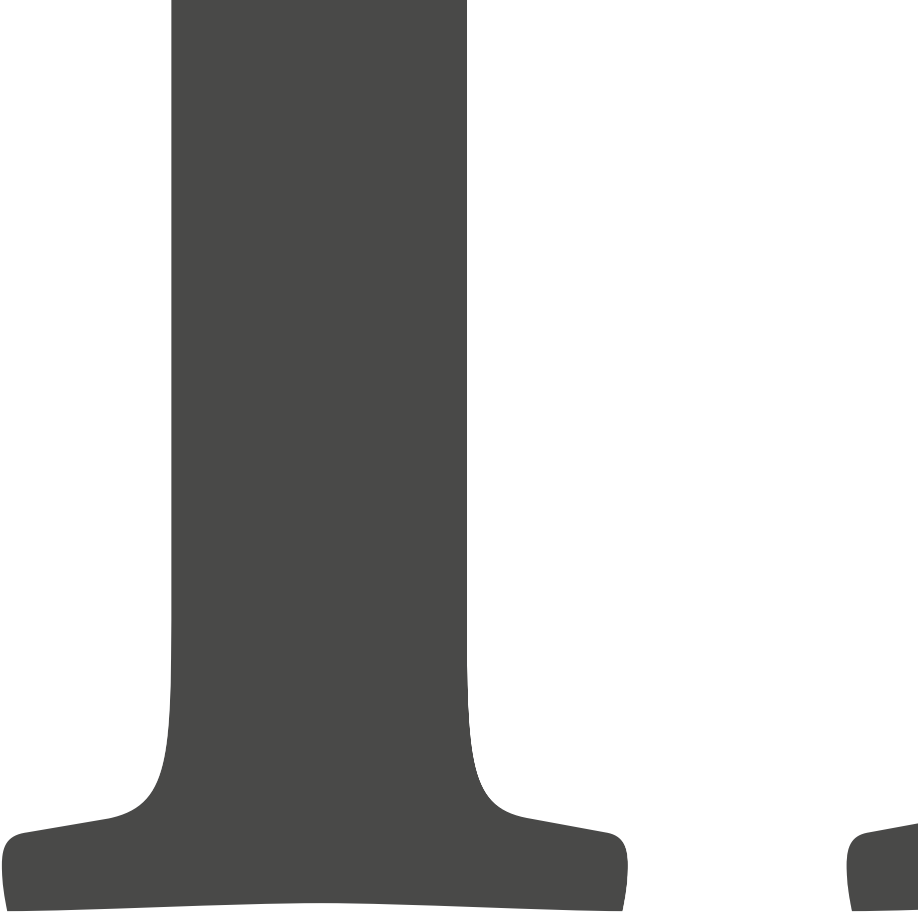


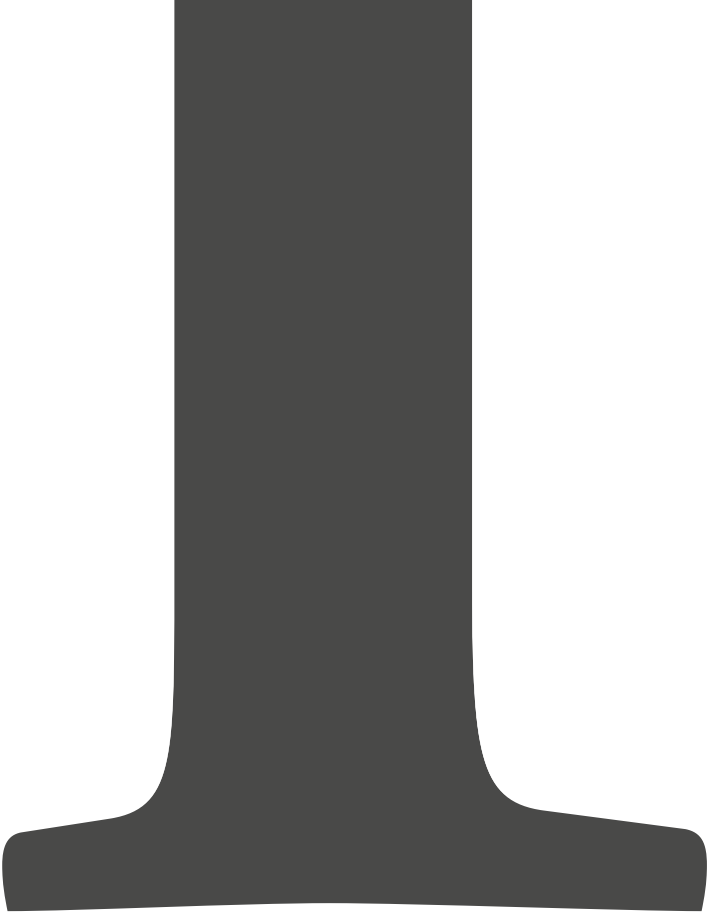




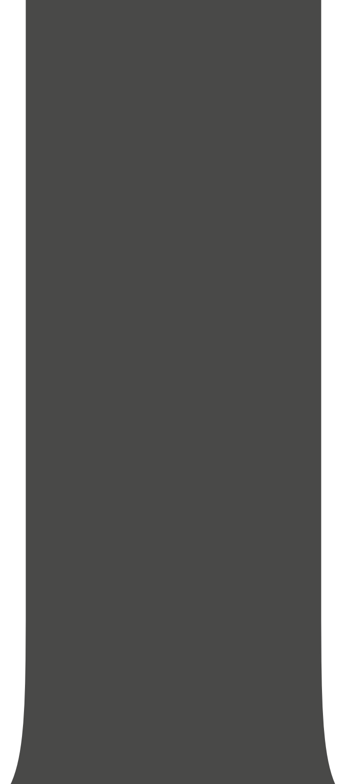


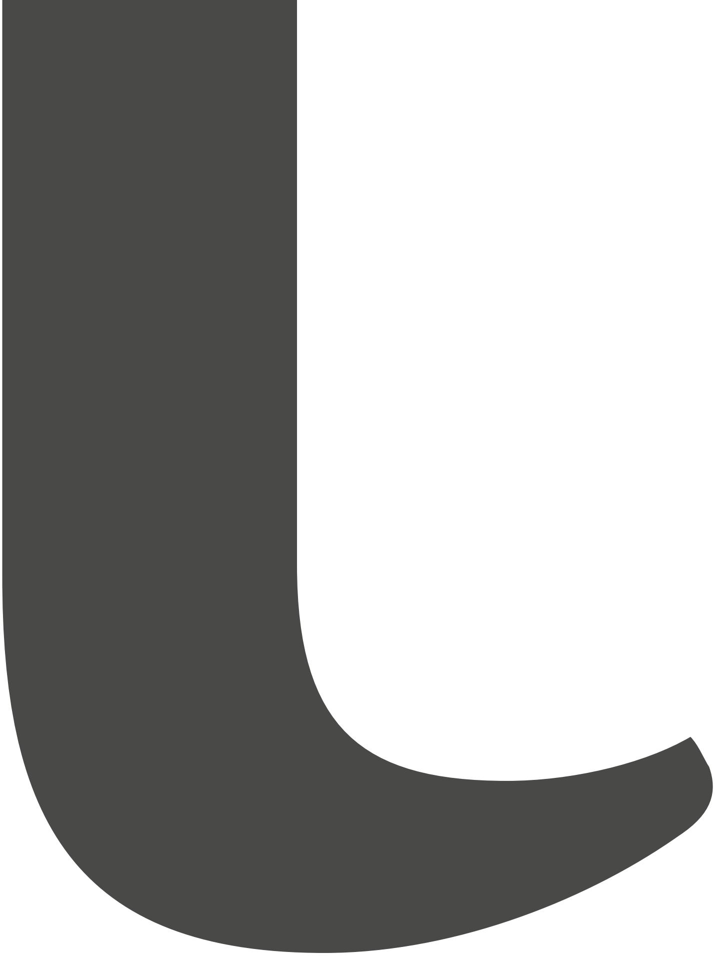


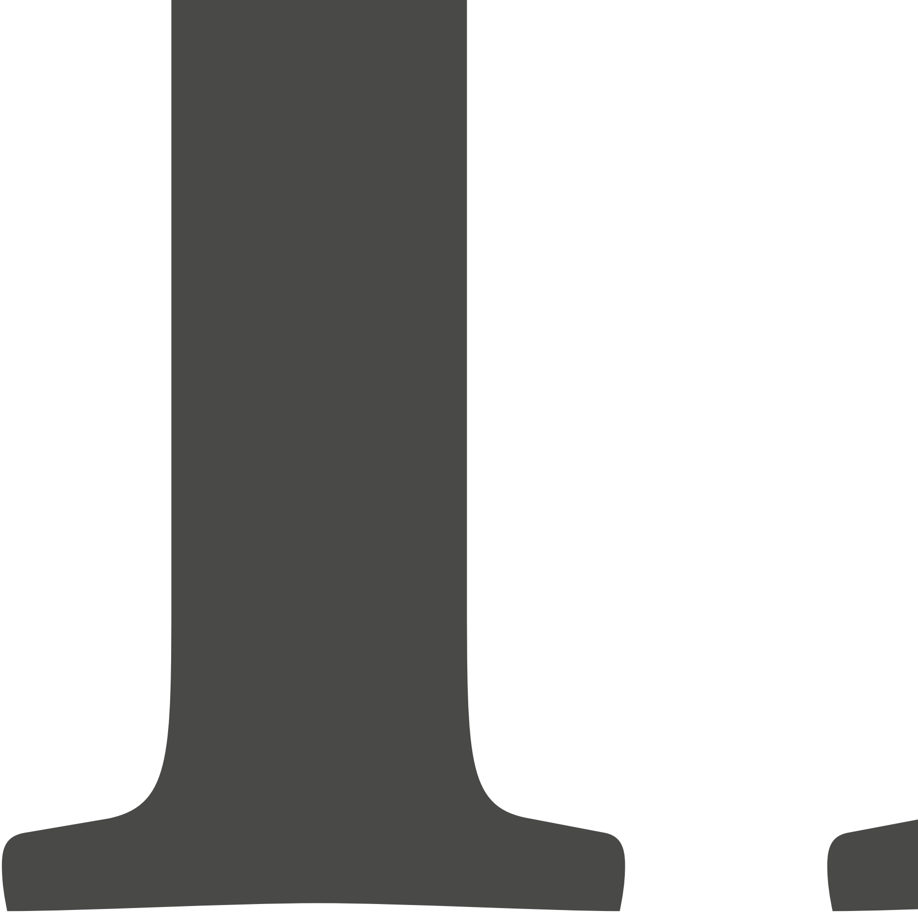




V



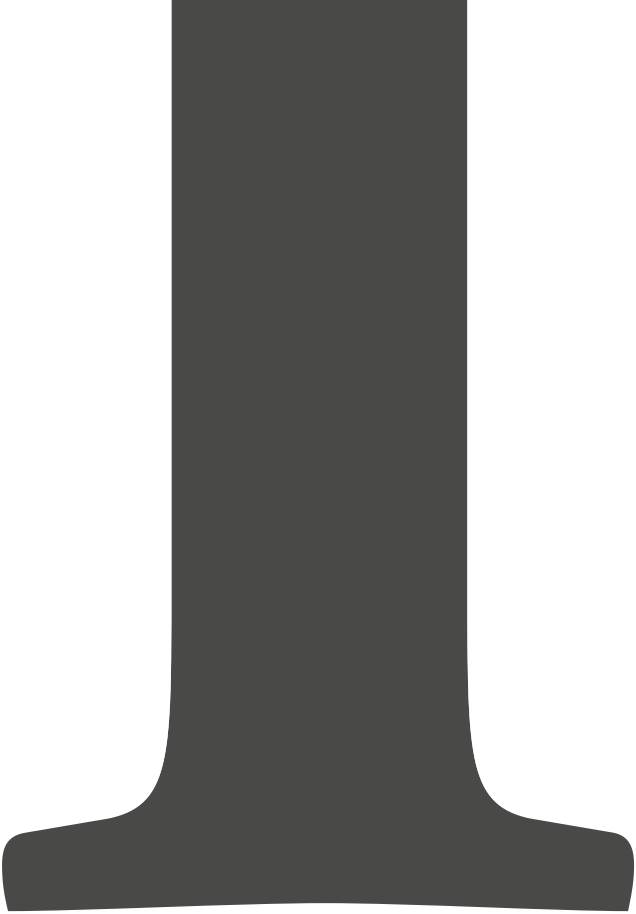


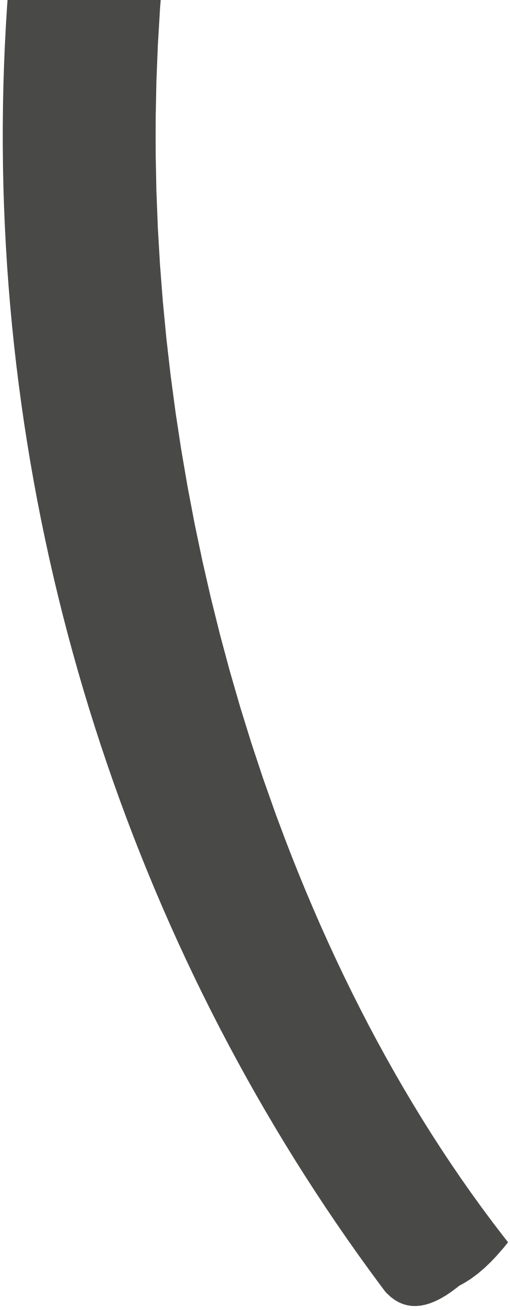


K

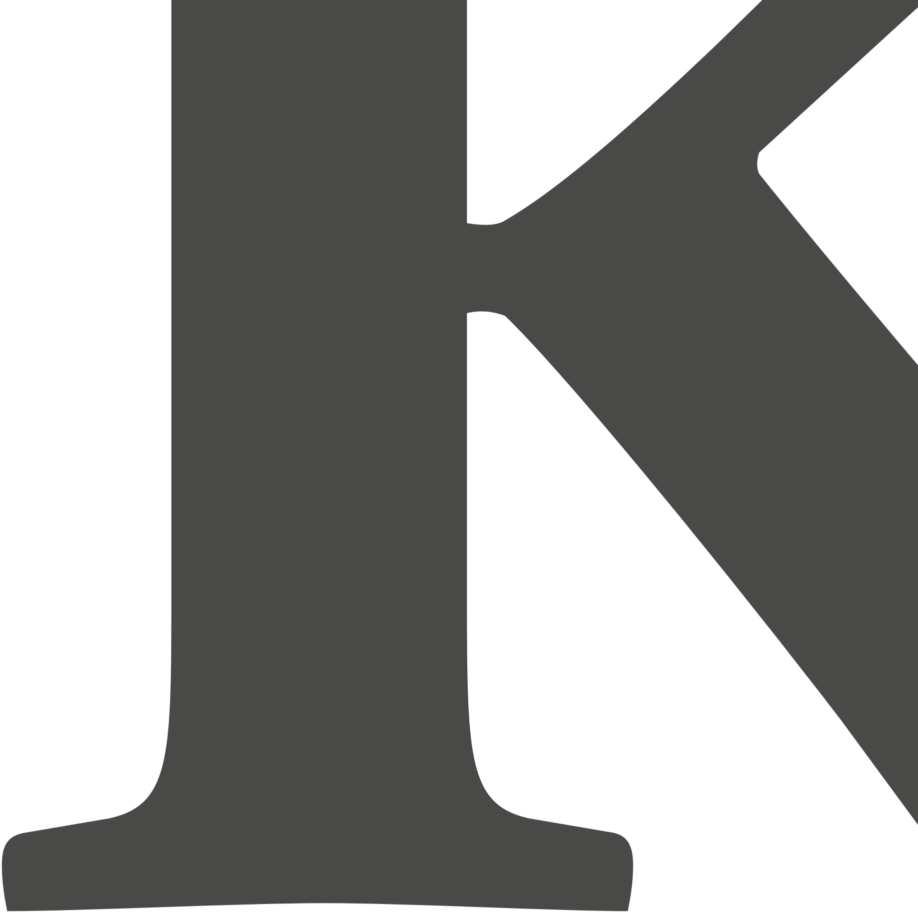
4

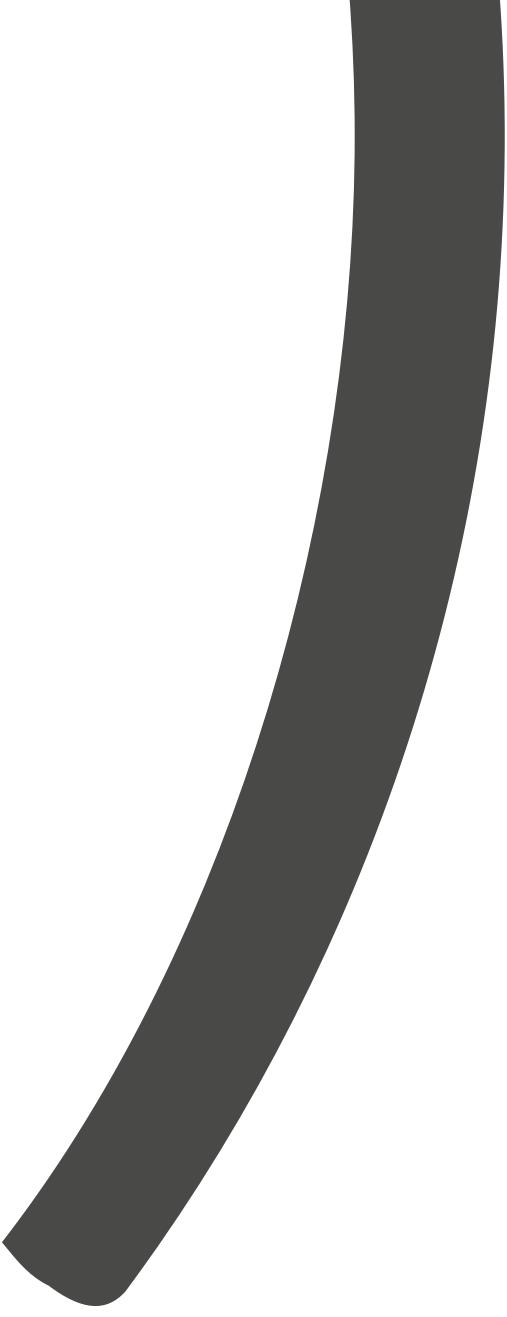
4

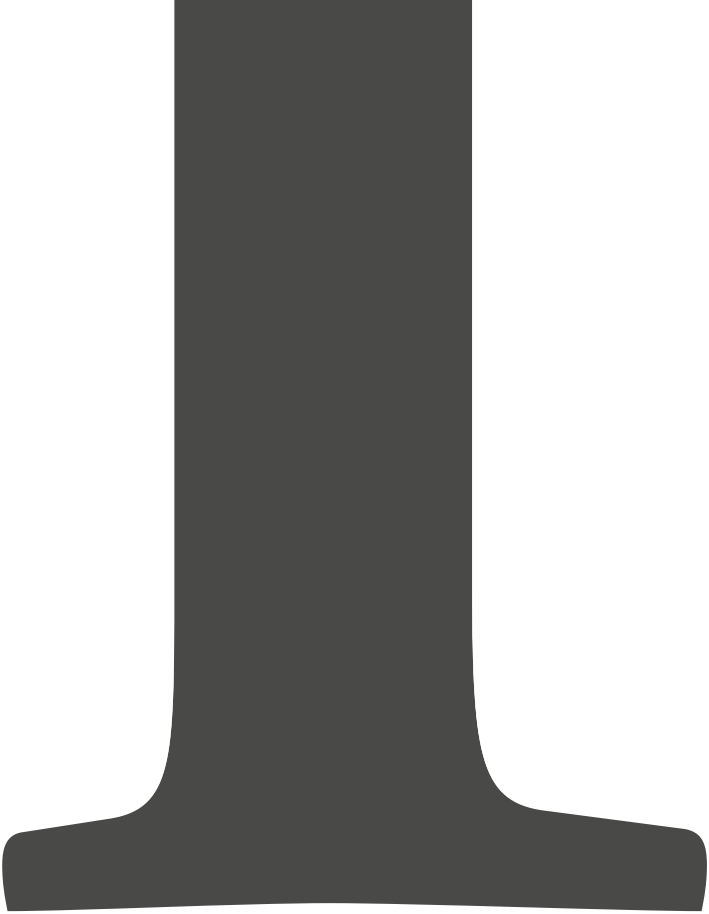




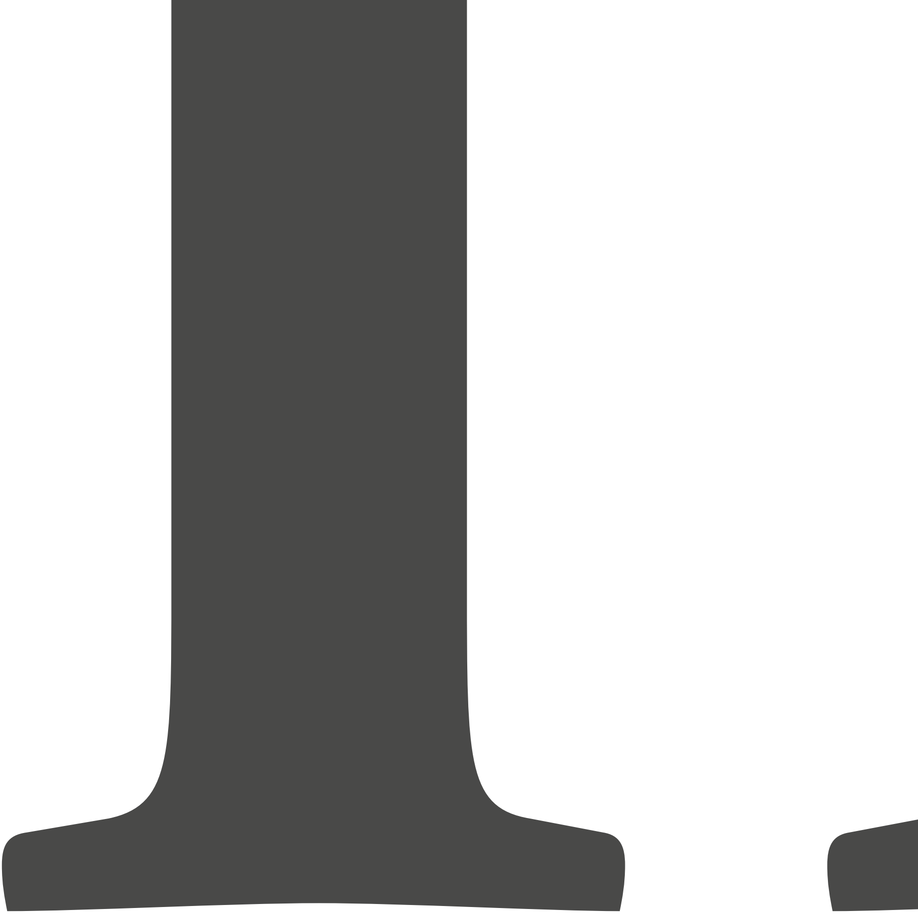
2

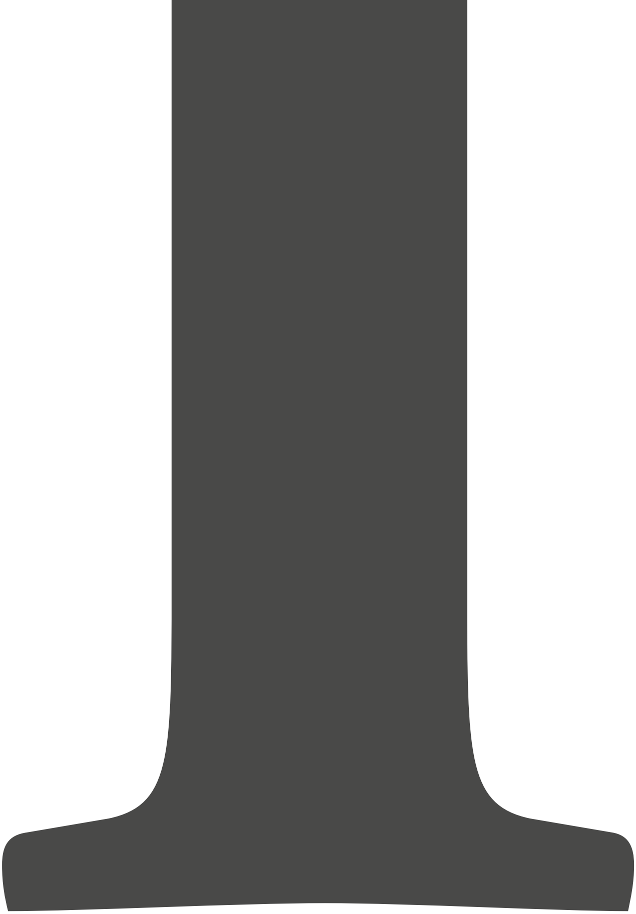


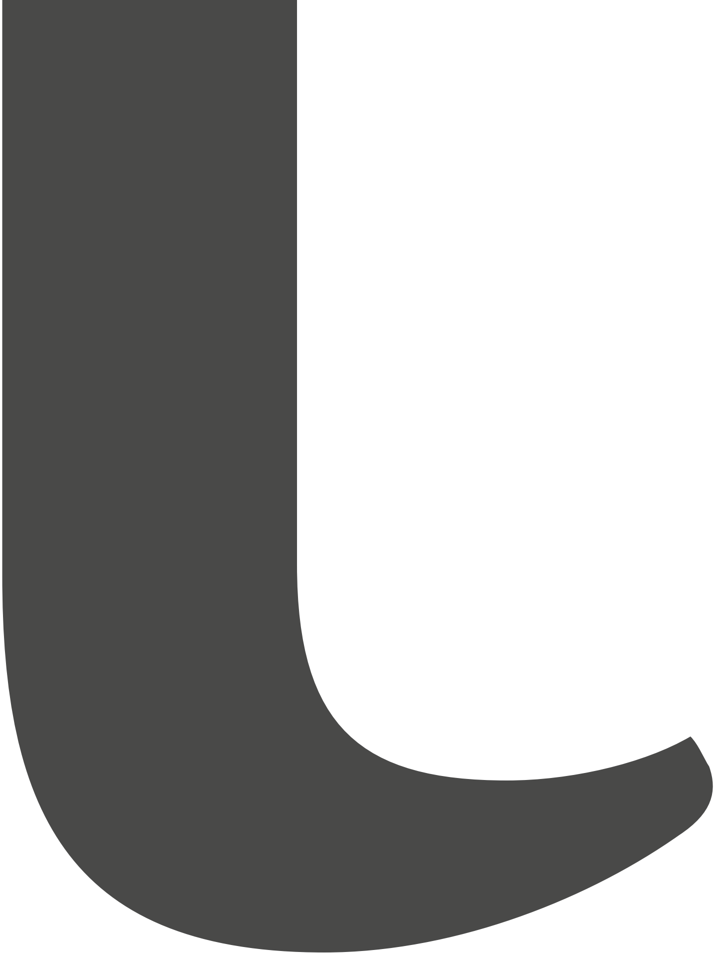


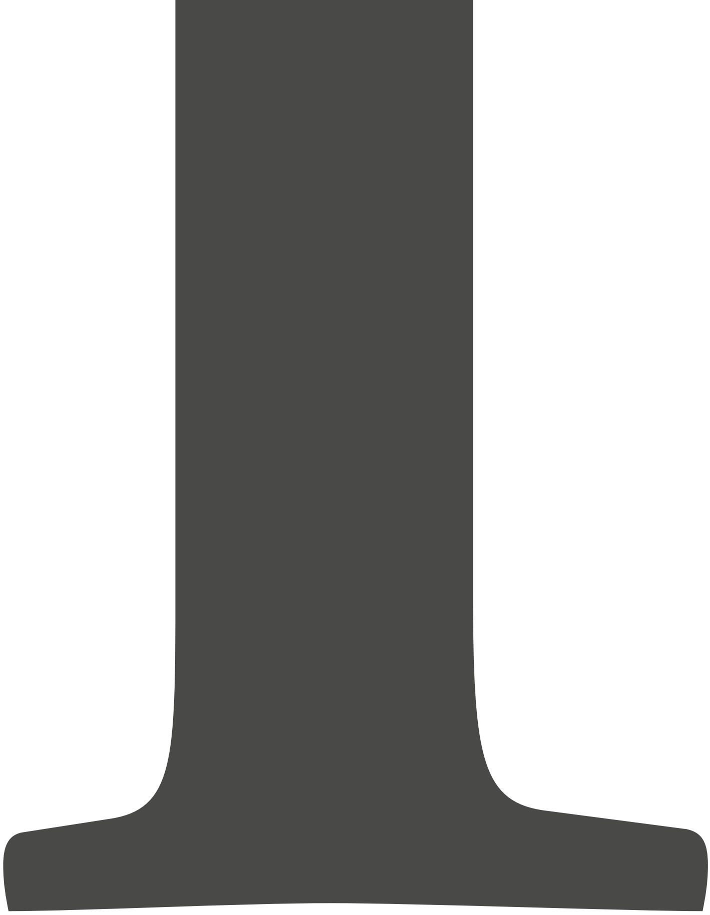


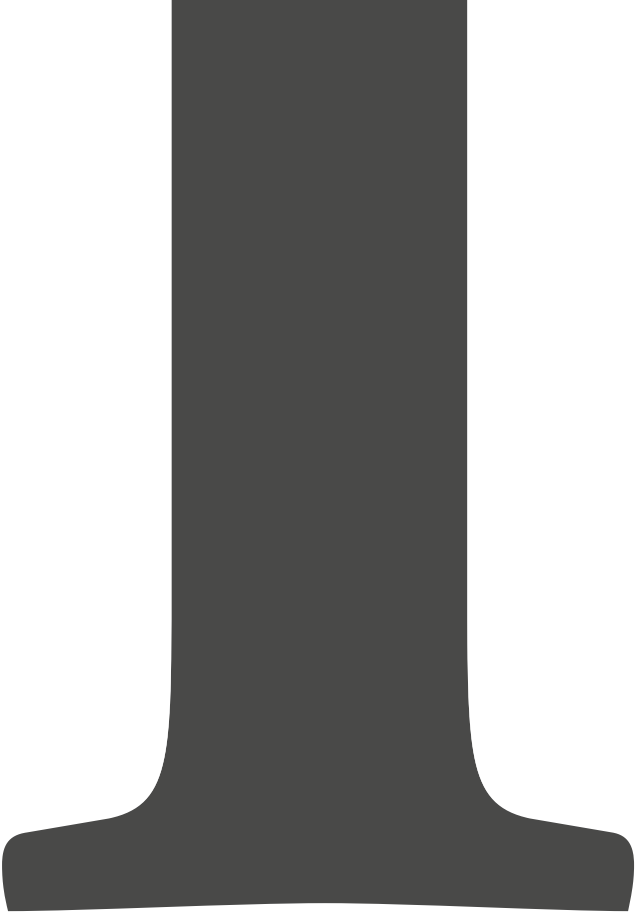
V

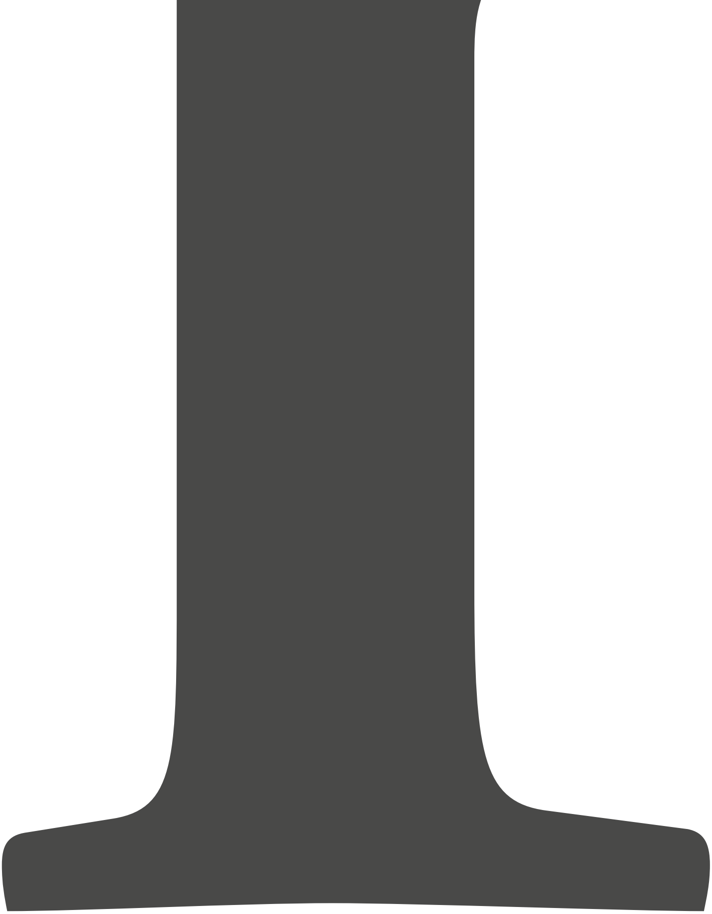


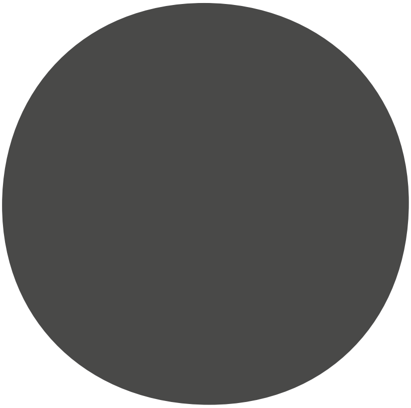












A

t

kr

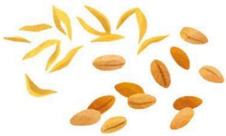
Wheat

Common

(Triticum ae

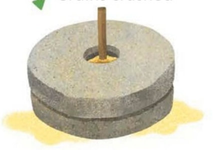
Wheat is grow
continent excep
The biggest pro
China, India
and the

Seed cases removed



Ears of wheat harvested

Grains crushed



Making flour

Ears of wheat are harvested with part of the stalk attached. They are beaten, or threshed, to remove the stalks. Air is then blown over them to remove the seed cases, known as chaff, leaving just the grains behind. The grains are finally crushed between steel rollers or heavy stones to produce the powder we call flour.

[redacted]

W

C

T

C

a

E

st

re

re

ju

C

p

E

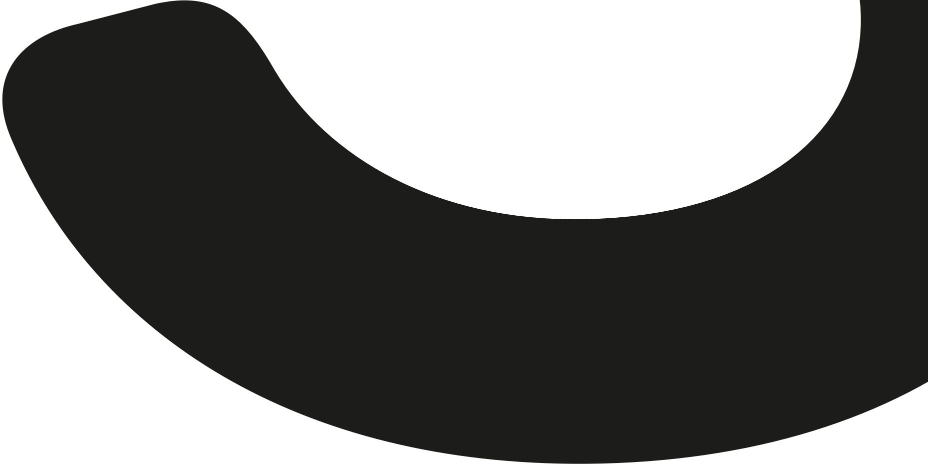
h

S

re

G

Tasty seeds



T

W

h

C

C

W

a

tr

th

a

C

E

w

a

p

K

se

W

m

K

Li

d

p

a

a

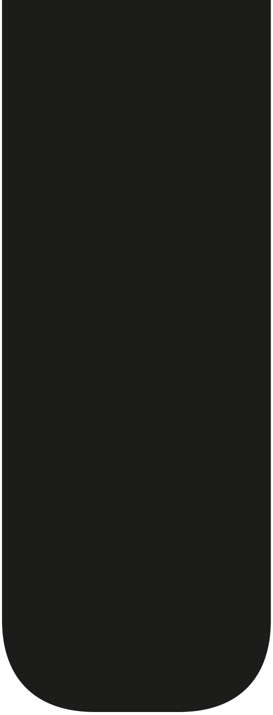
R

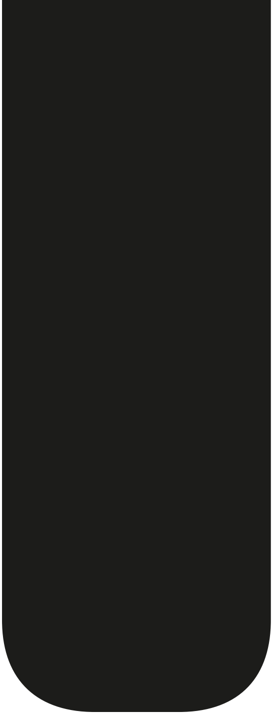
g

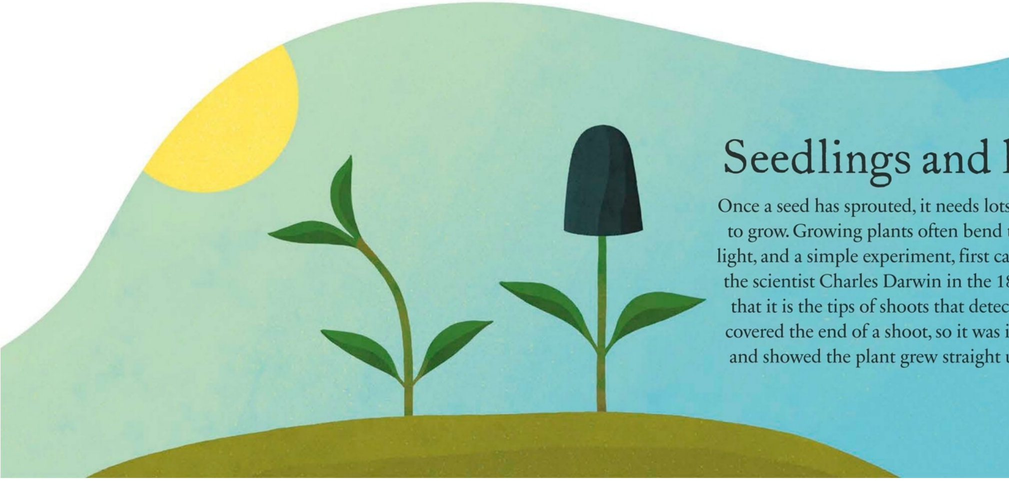
fi

T

th







Seedlings and

Once a seed has sprouted, it needs lots
to grow. Growing plants often bend t
light, and a simple experiment, first ca
the scientist Charles Darwin in the 18
that it is the tips of shoots that detec
covered the end of a shoot, so it was i
and showed the plant grew straight u

[redacted]

[redacted]

[redacted]

P

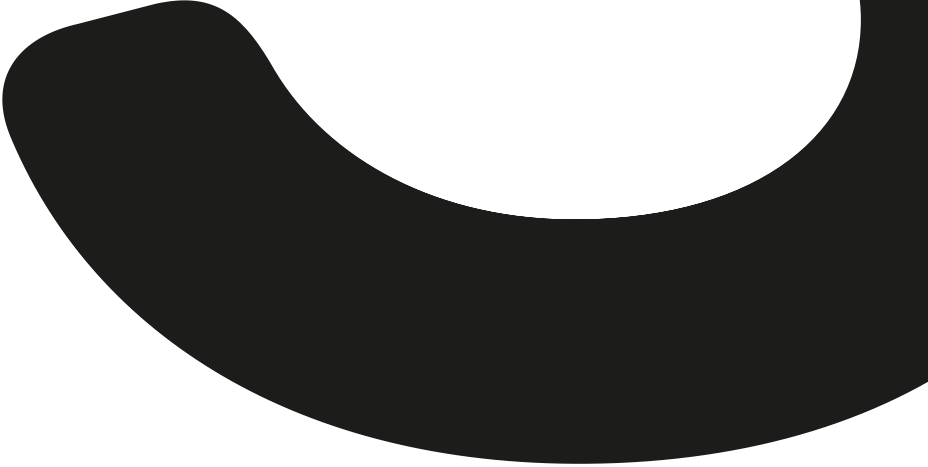
u

W

F

g

a



T

a

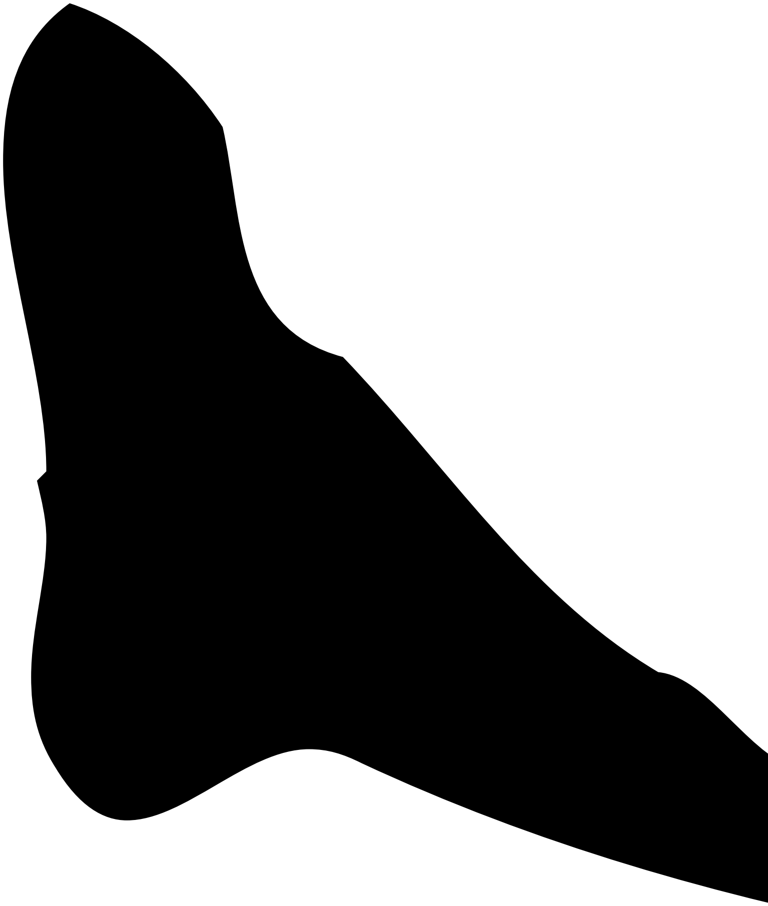
a

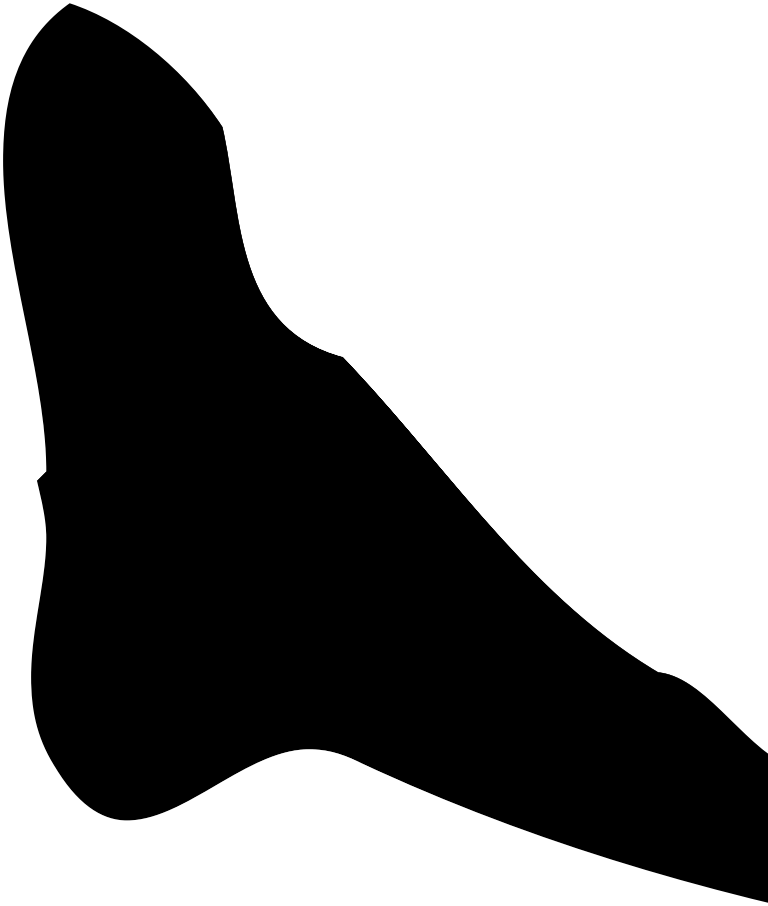
S

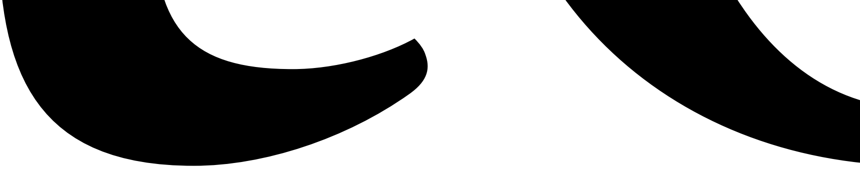
tu

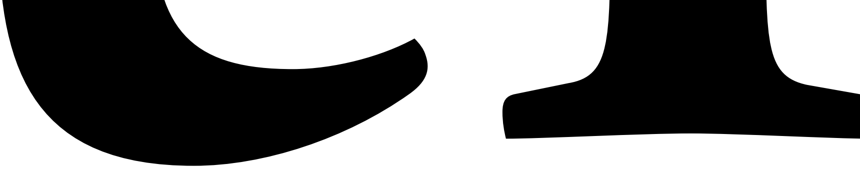
b

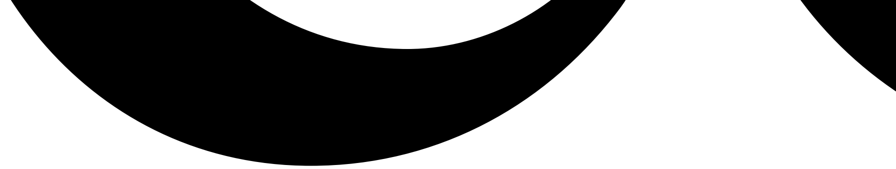
f











S

C

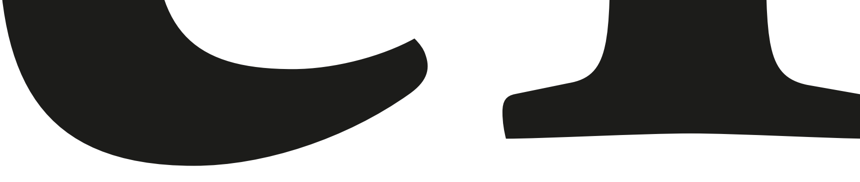
E

sh

C

O

Corn



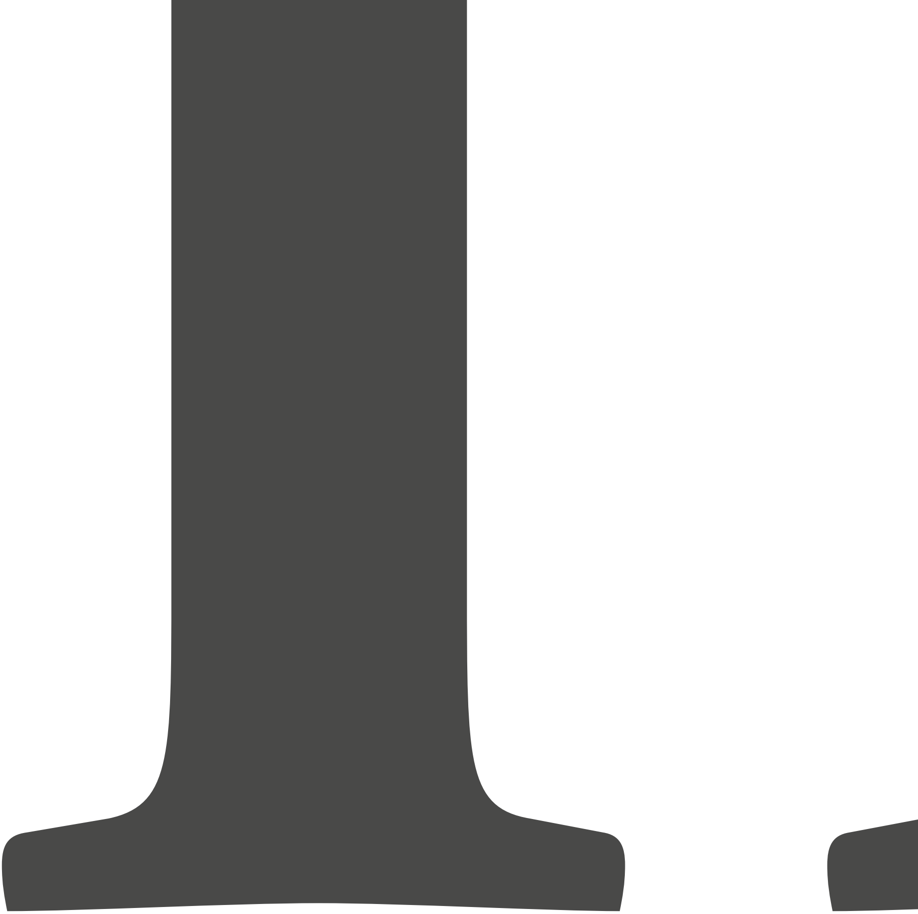
C

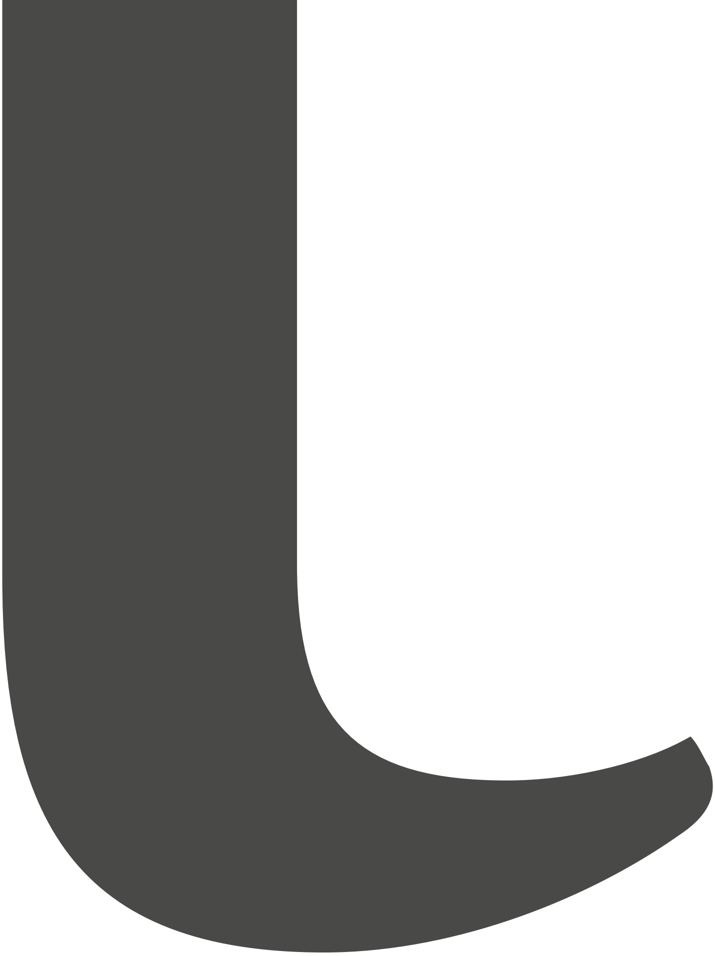
h

fe

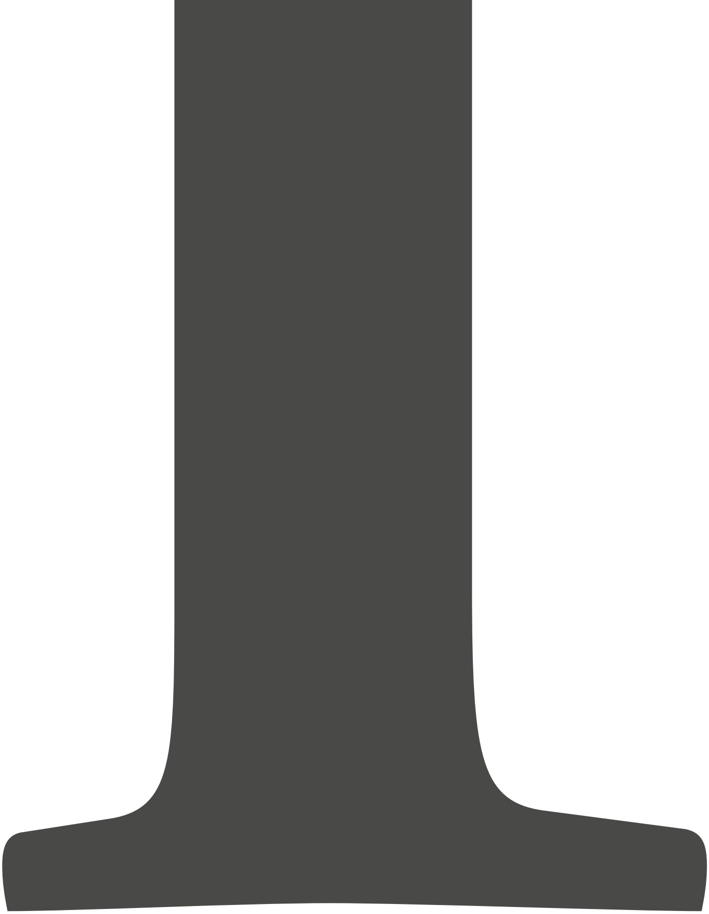
b

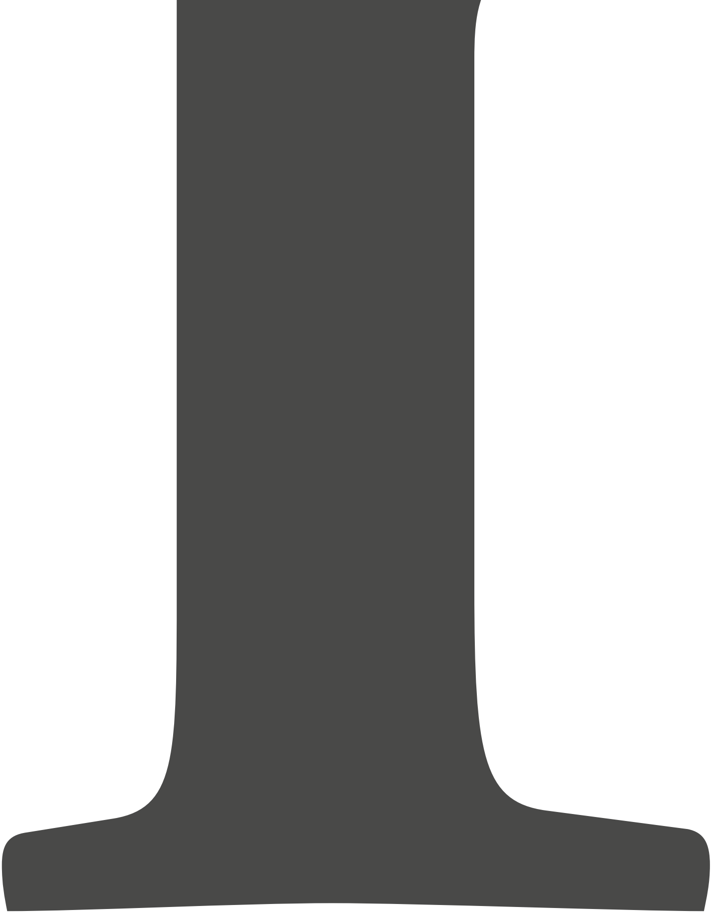
C

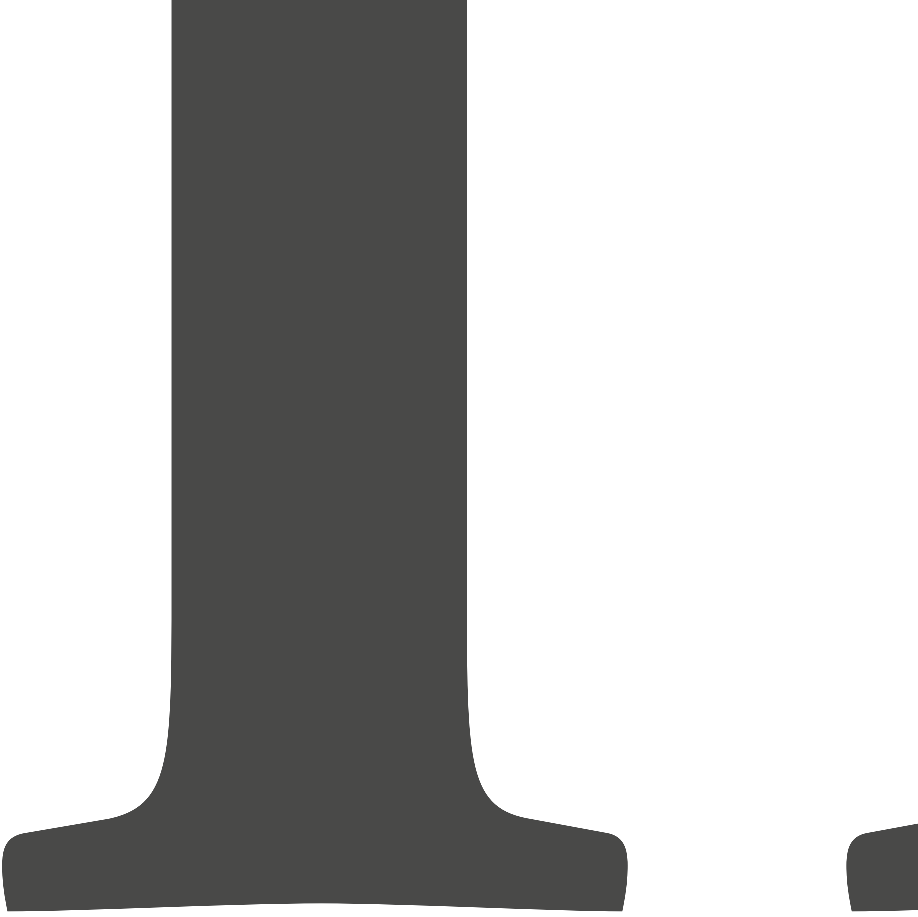




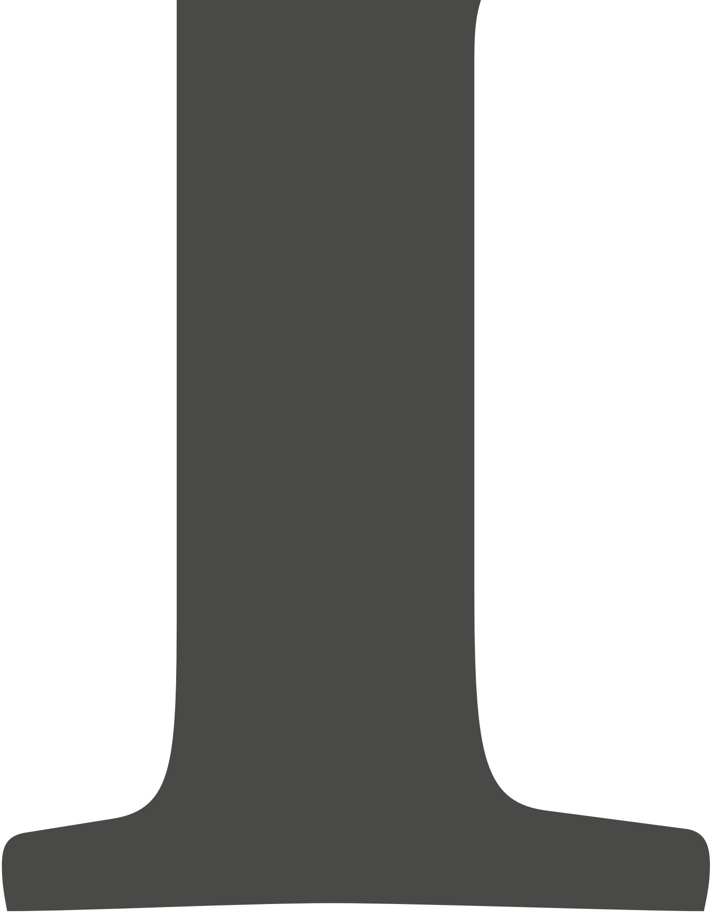
y

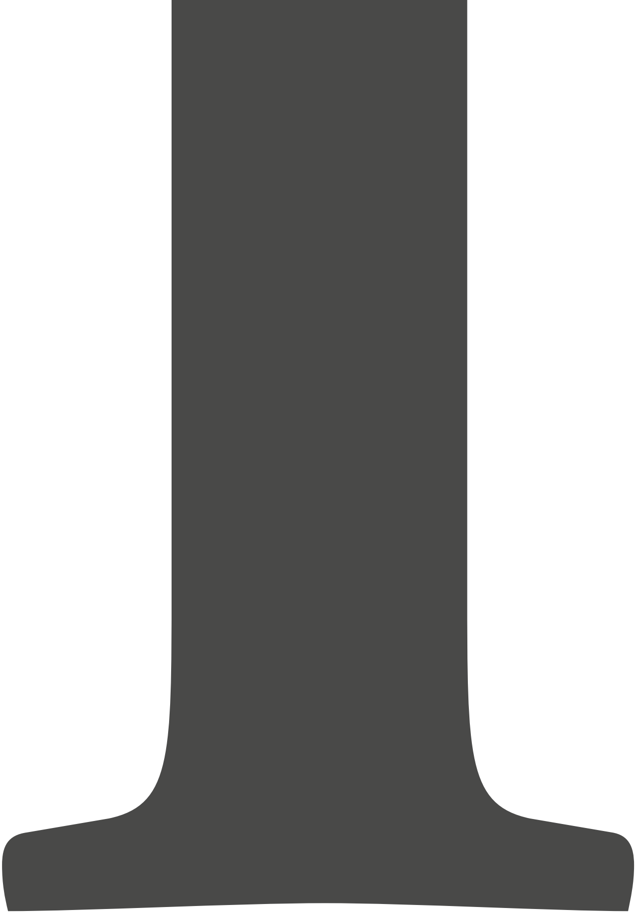


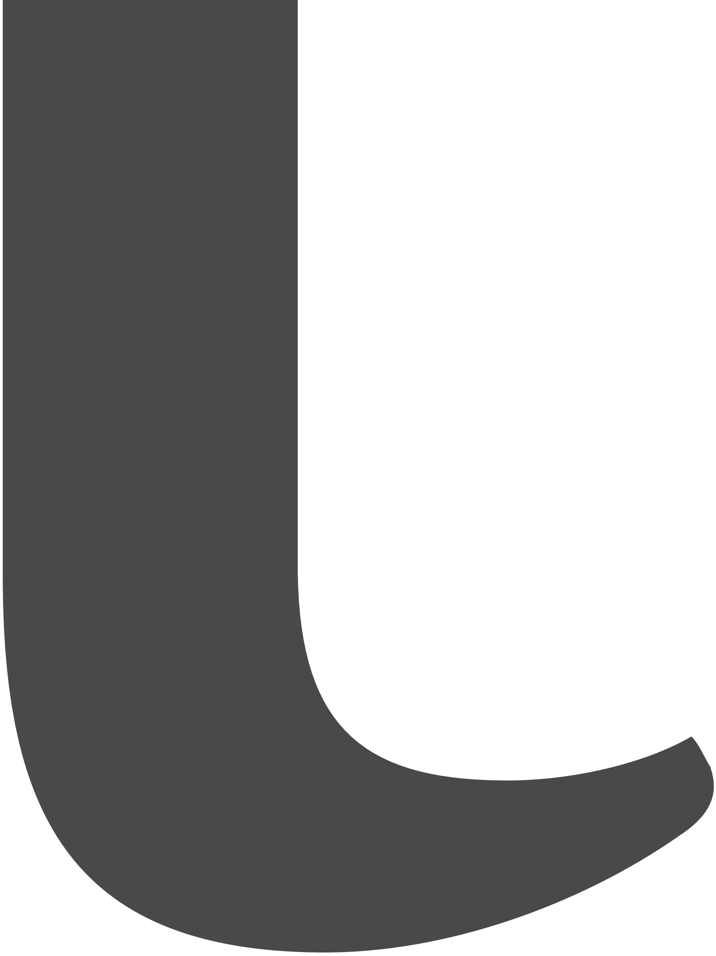




V



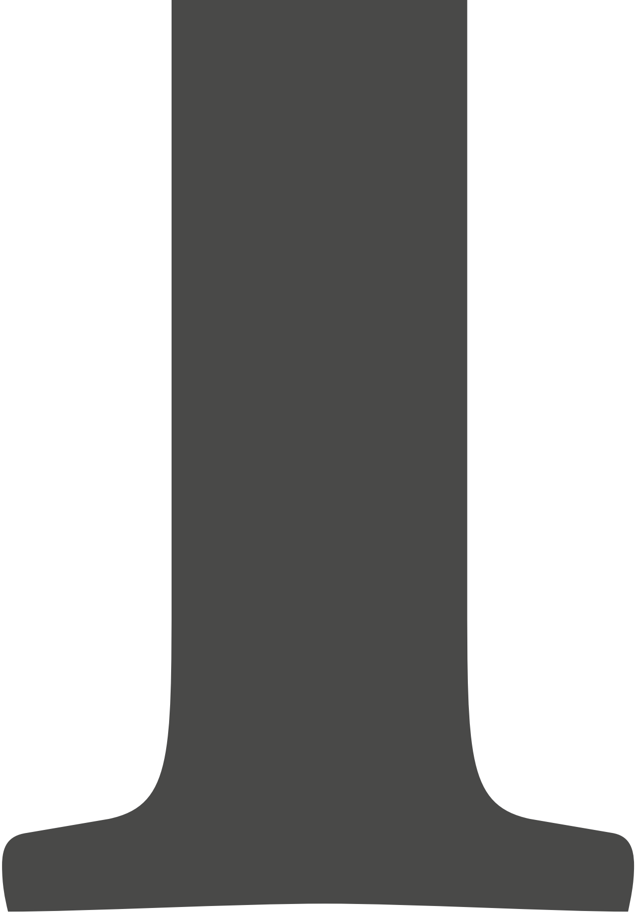


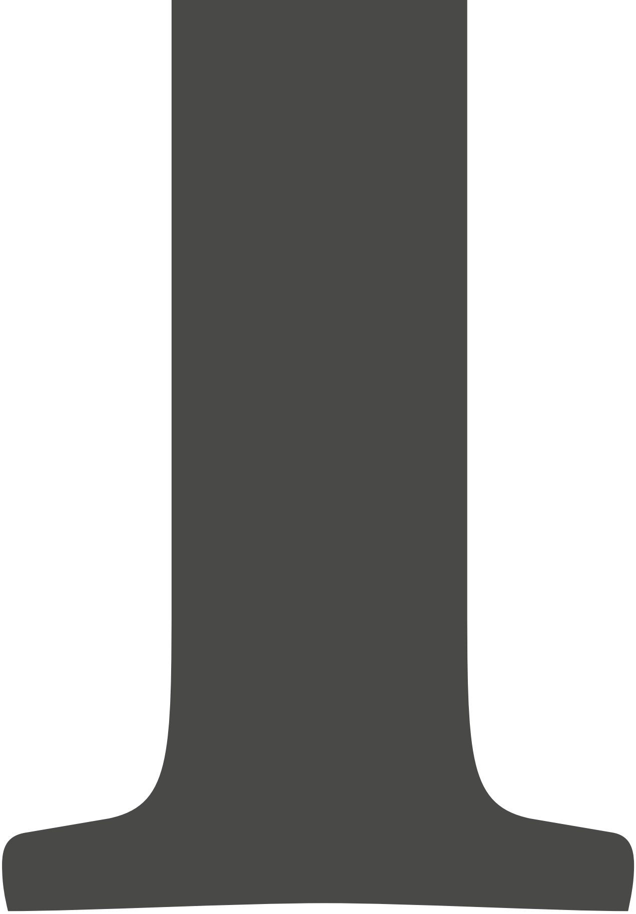


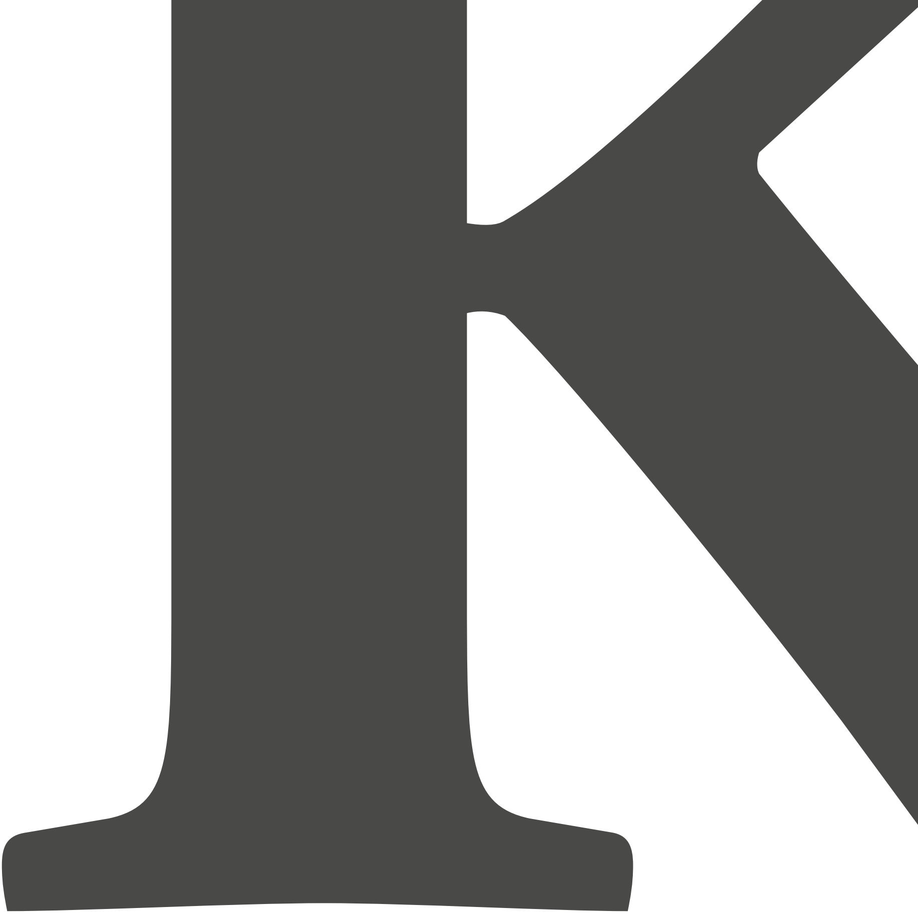
’

J

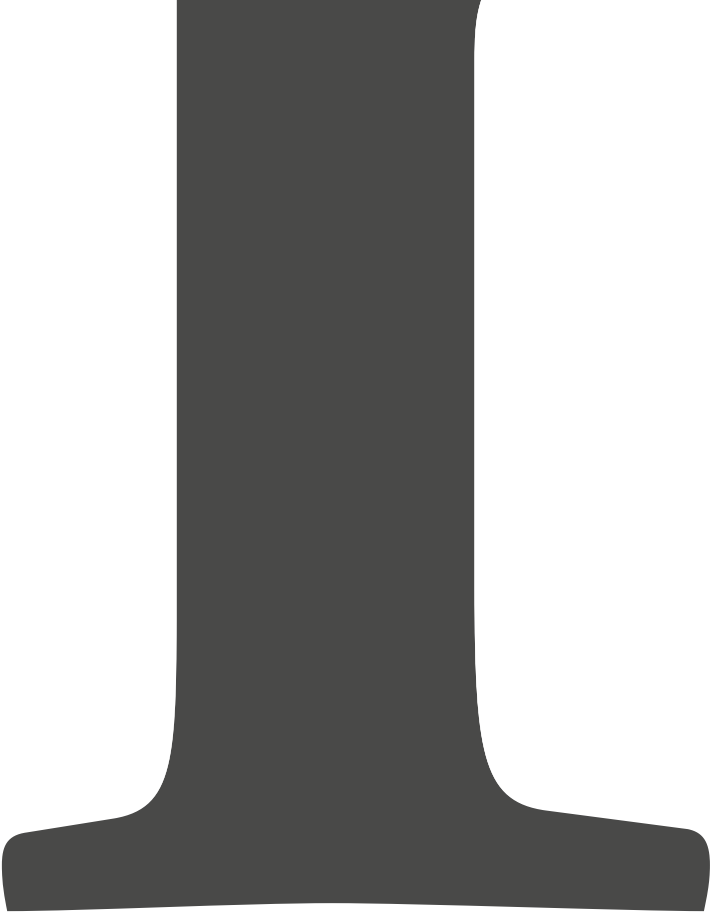
V

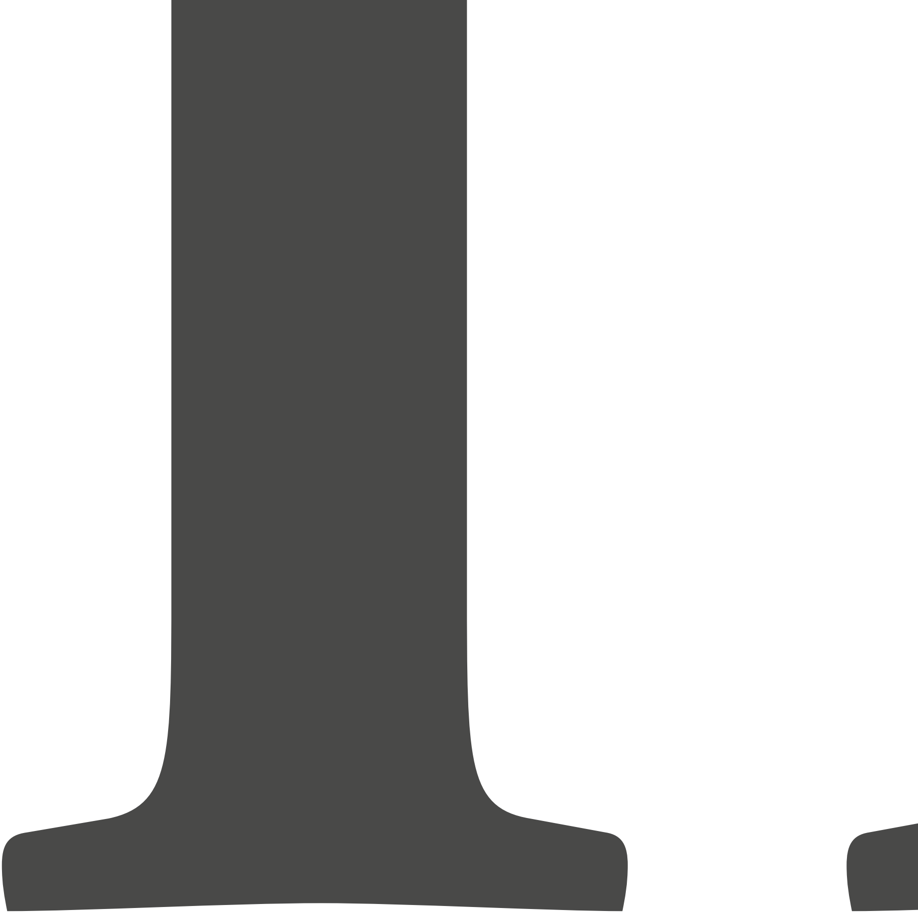


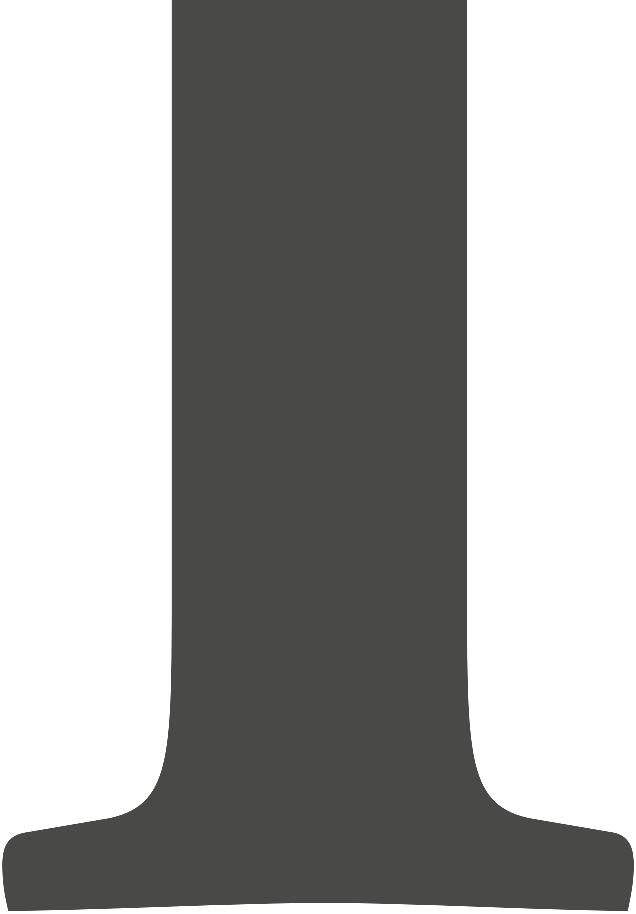


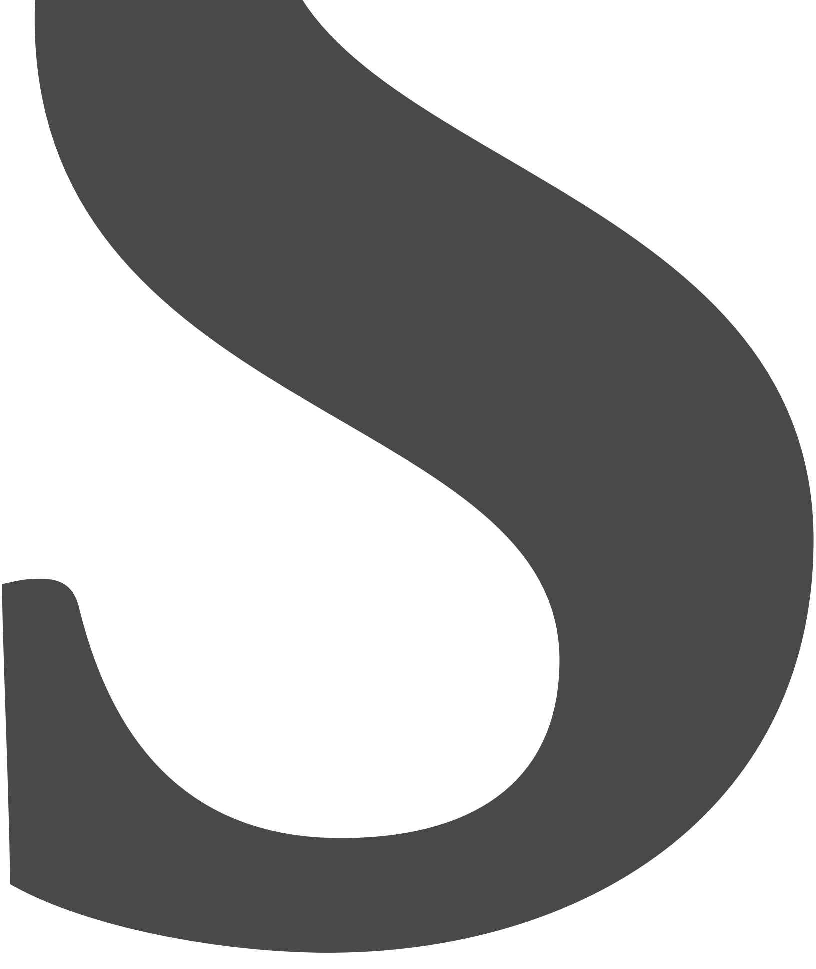


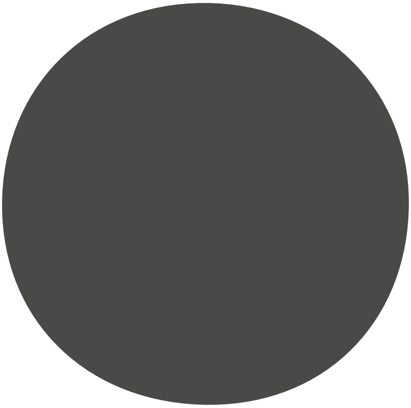
K

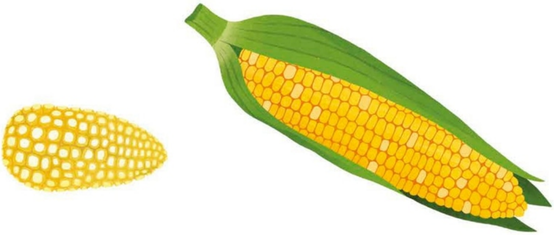












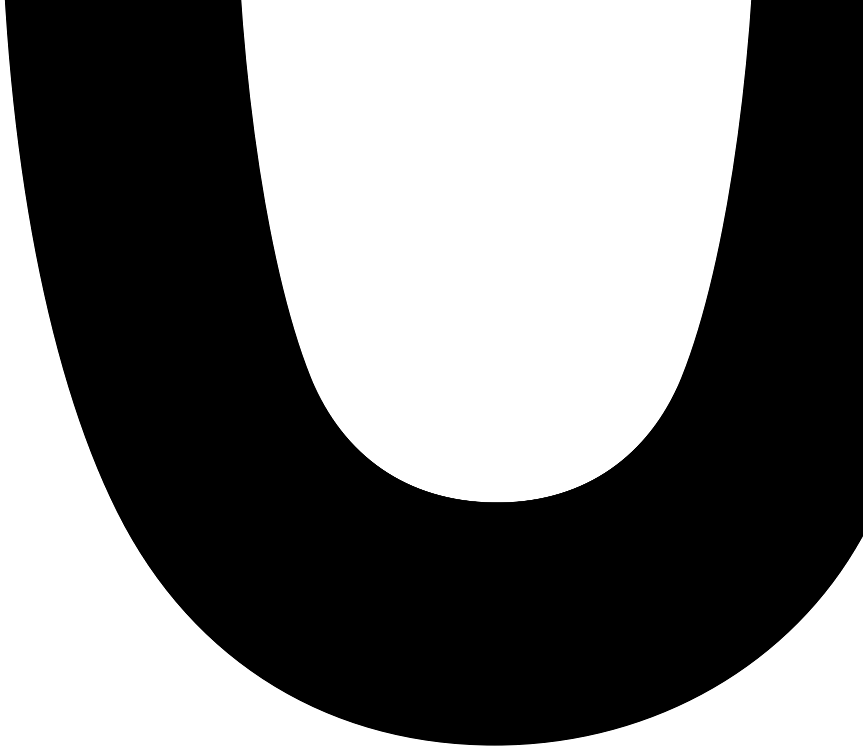
Changing corn

The ancestors of corn, called teosintes, had small cobs with a few hard kernels. Farmers selected plants with the best cobs and the next year grew only their kernels. Over many generations, the cobs became larger, with softer, juicier kernels.

Corr

(Zea ma

Corn belongs to
grasses with ed
called cereals
relatives lived i
mounta

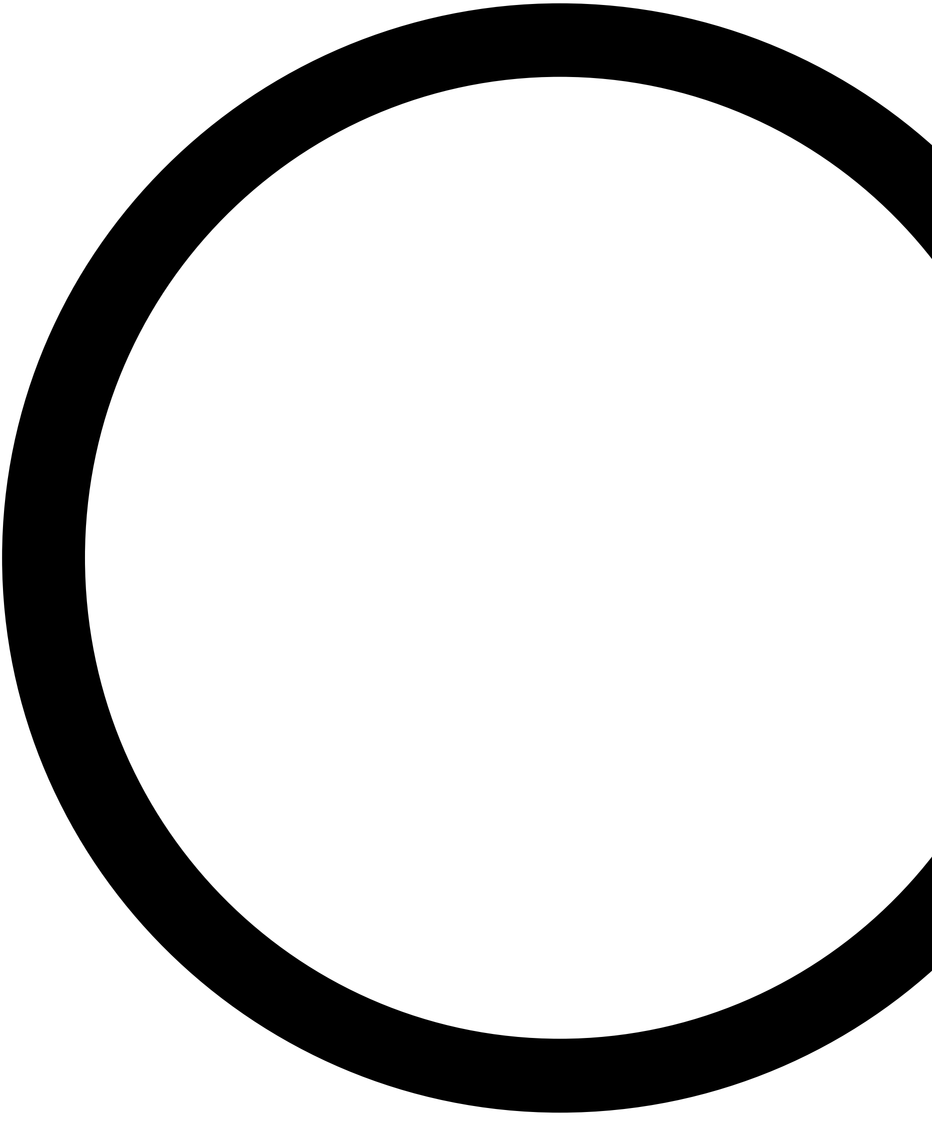


T

h

F

a



l

(2

C

g

C

re

m

T

M

T

a

CO

U

se

C

a

M

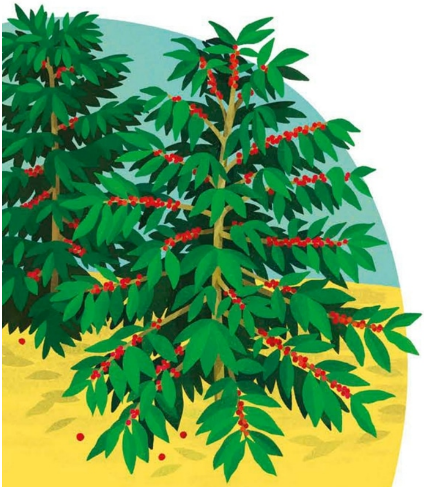
b

re

S

ty

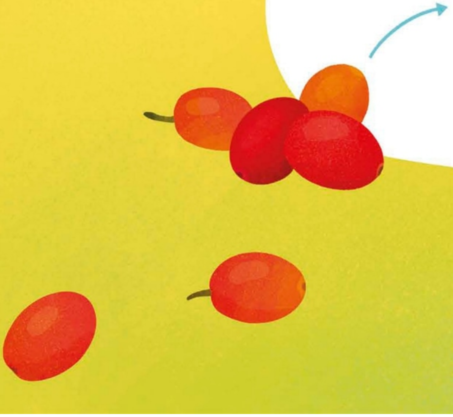
Coffee

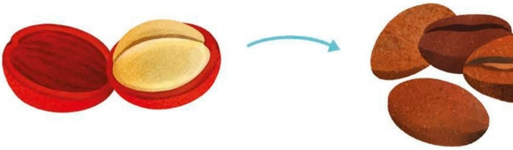


Coffee

(Coffea arabica)

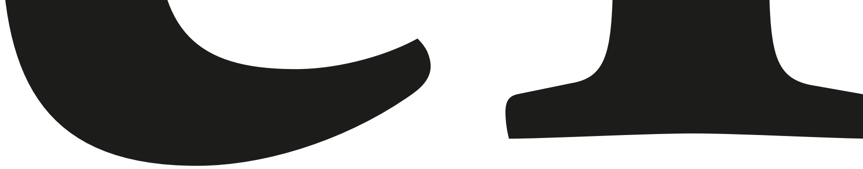
Africa has many types of coffee tree, but this is the one people cultivated first and still grow most of. Its mountain home is in Ethiopia.

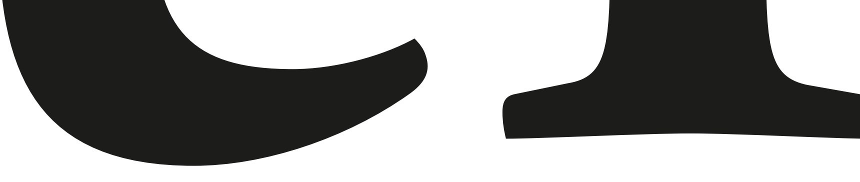




Inside a coffee cherry

Ripe coffee cherries are bright red. Inside each one is a pair of pale-colored beans. Before the beans are ready to use, they must be roasted, which turns them dark brown and brings out their flavor. The roasted beans are ground to a powder and added to hot water to make coffee drinks.





R

e

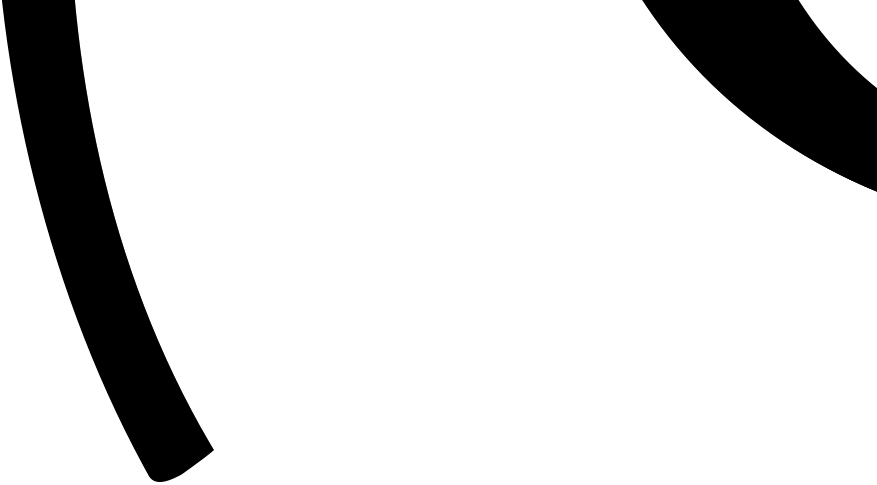
B

m

b

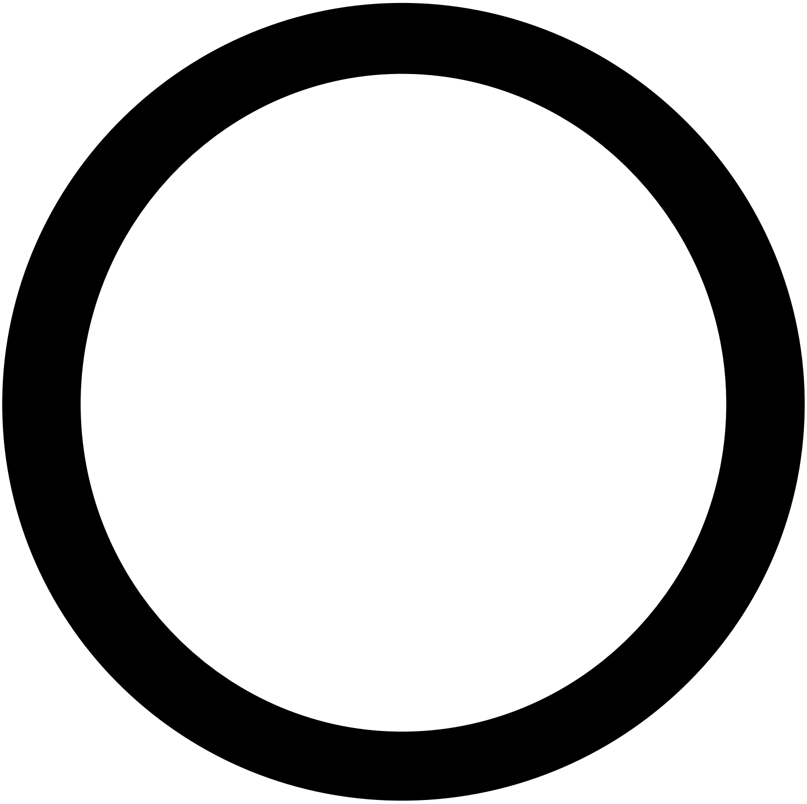
ro

a



A

C



a

m

in

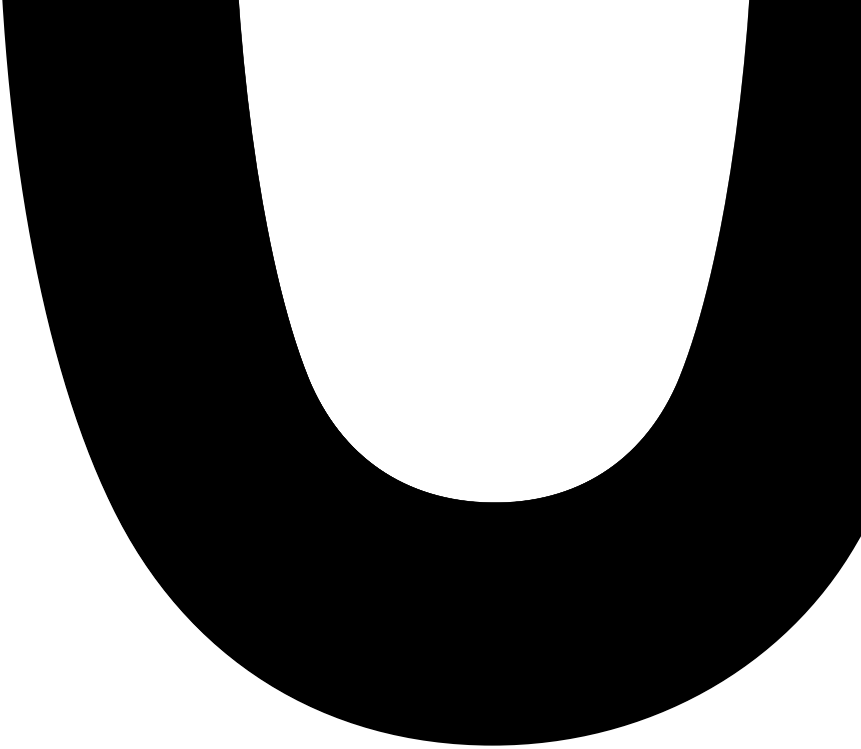
C

C

R

R

b



[redacted]

l

in

b

fi

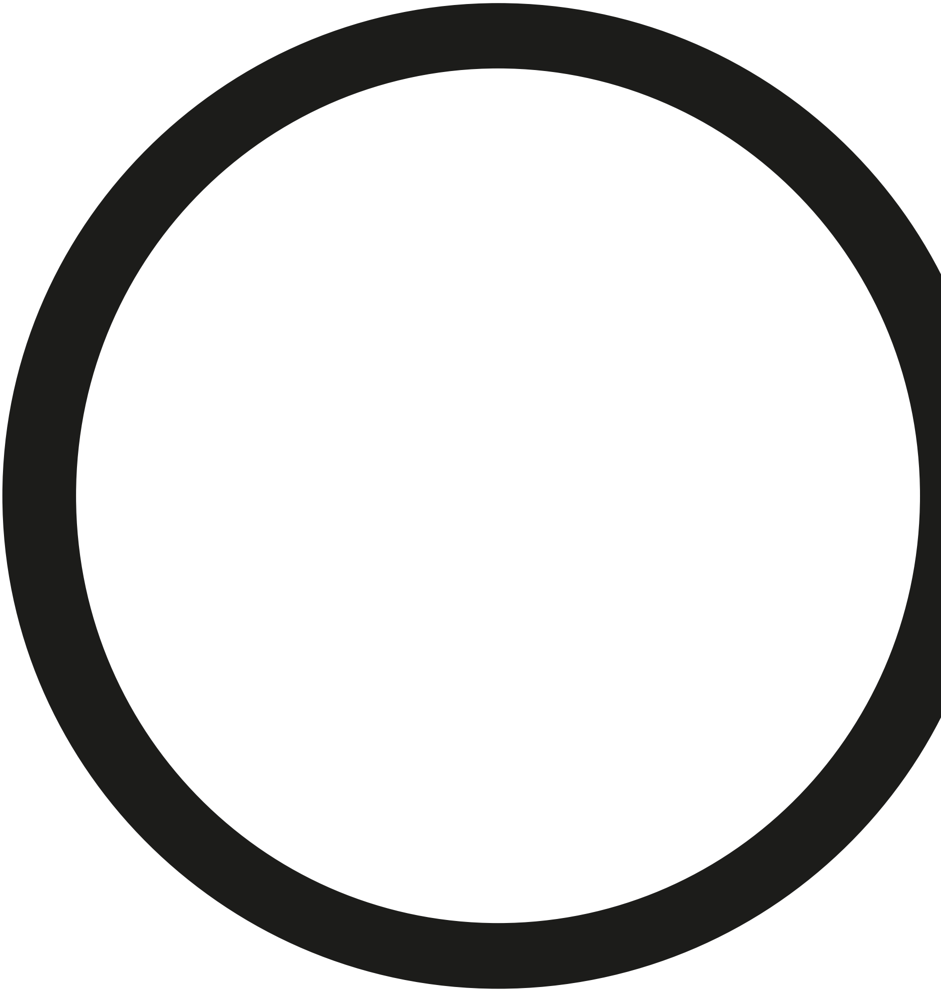
b

C

T

th

b



b

ot

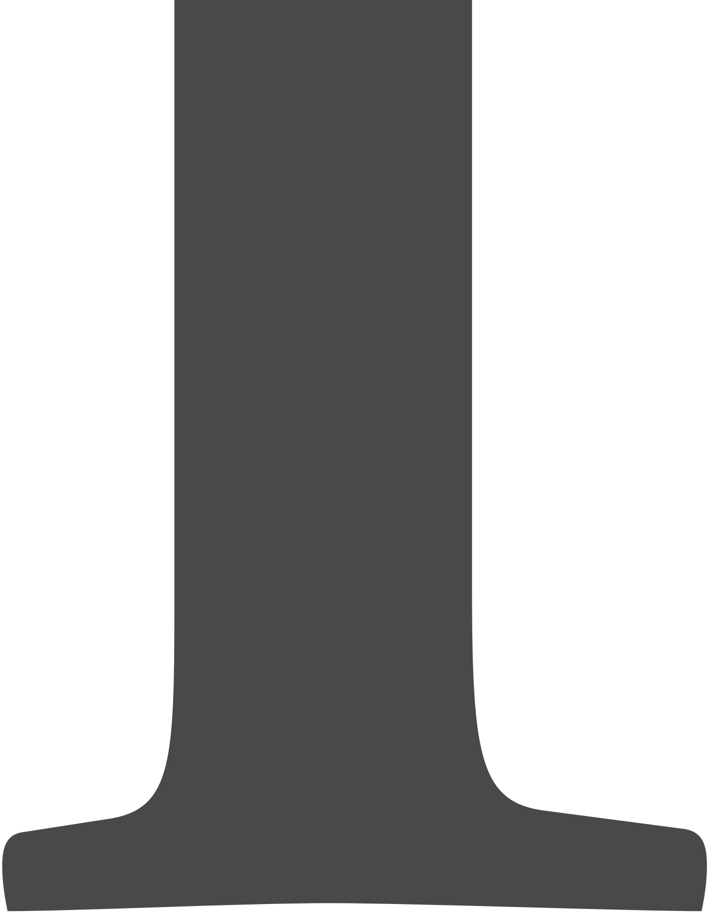
B

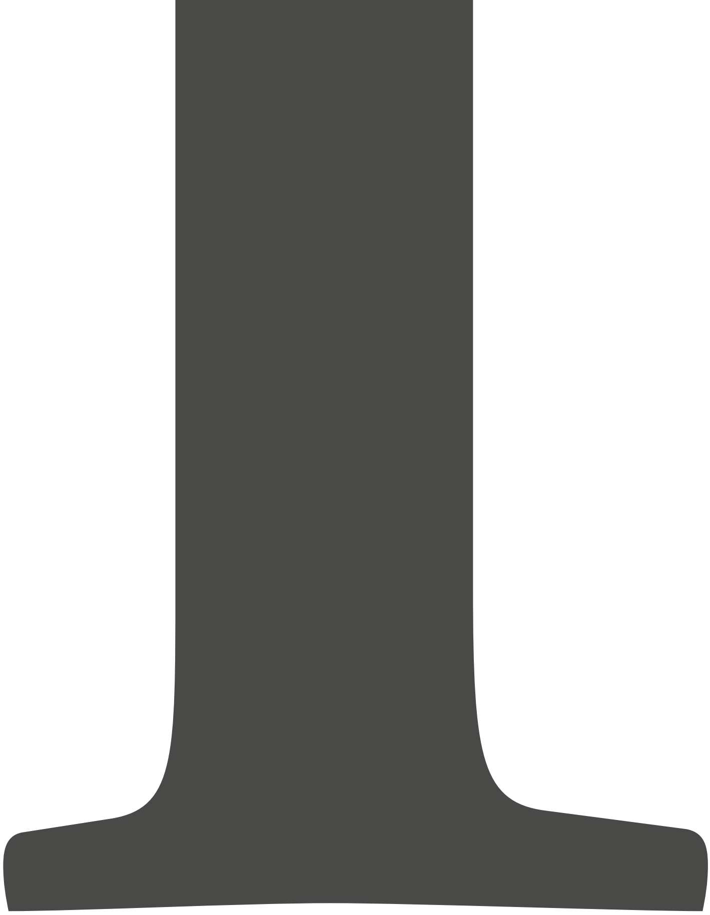
b

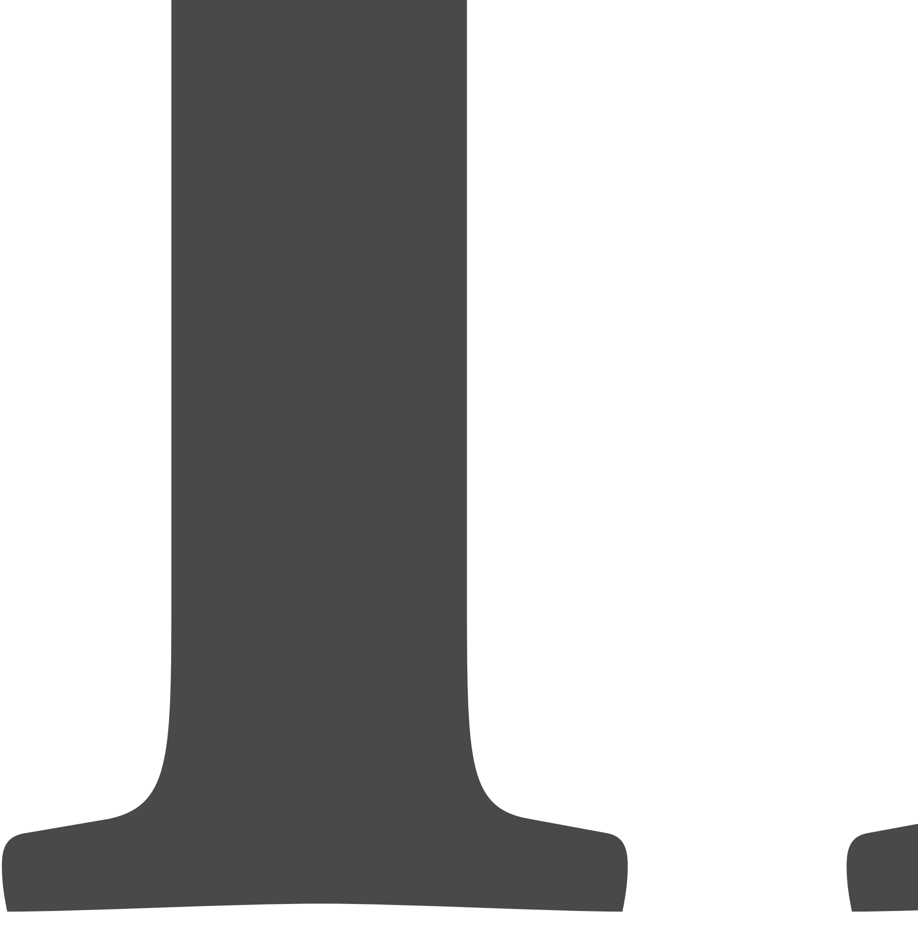
lf

d

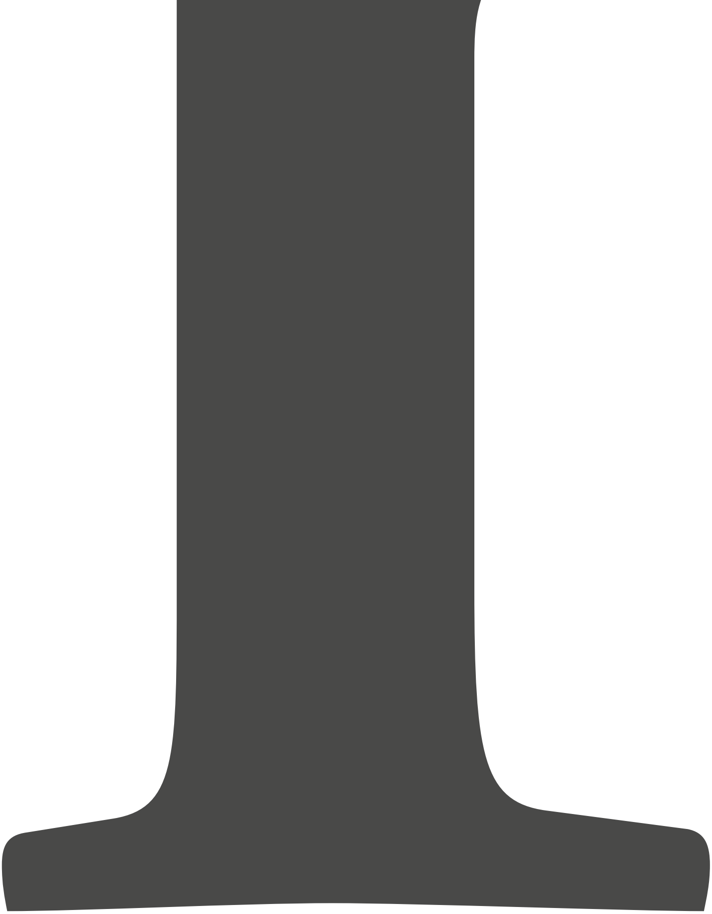
t

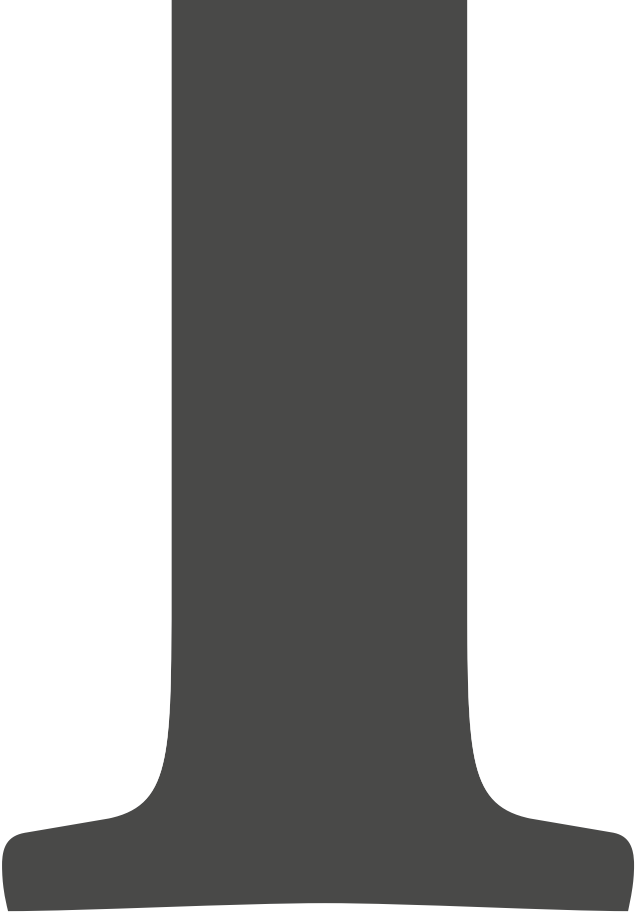






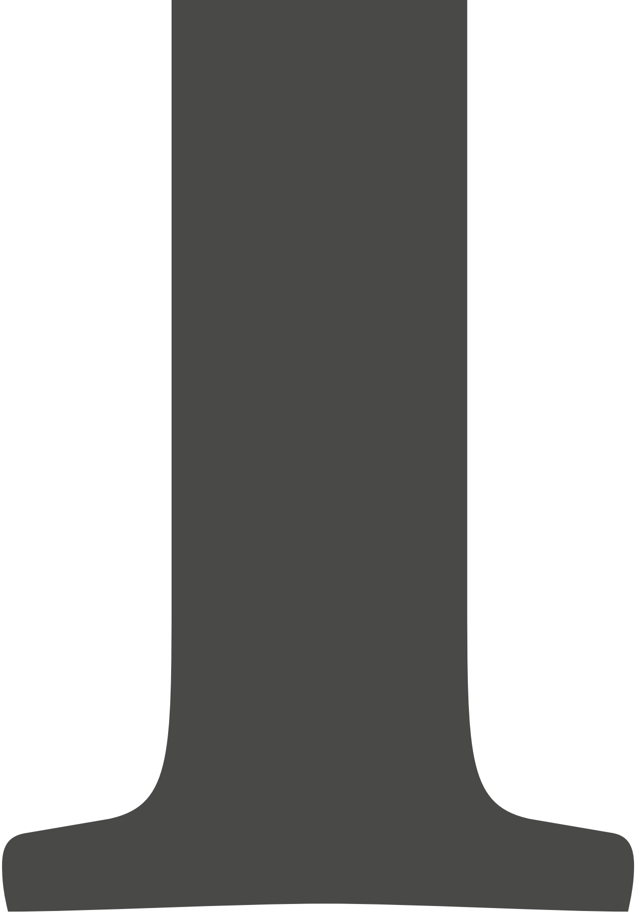
S

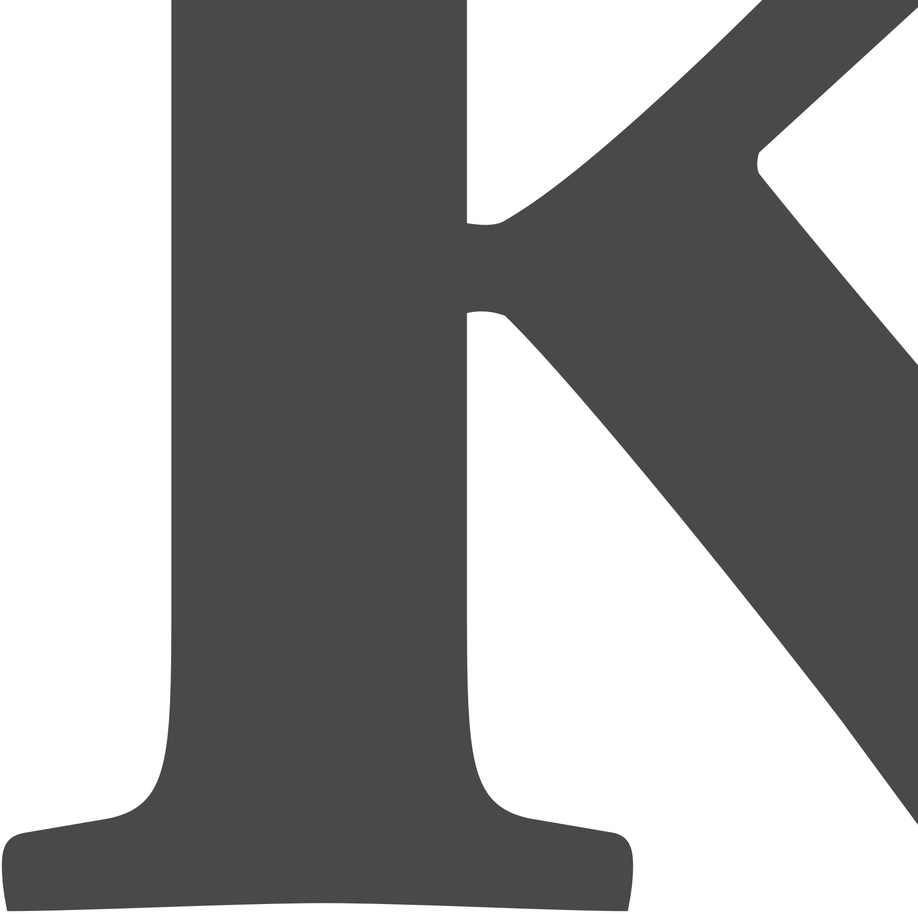




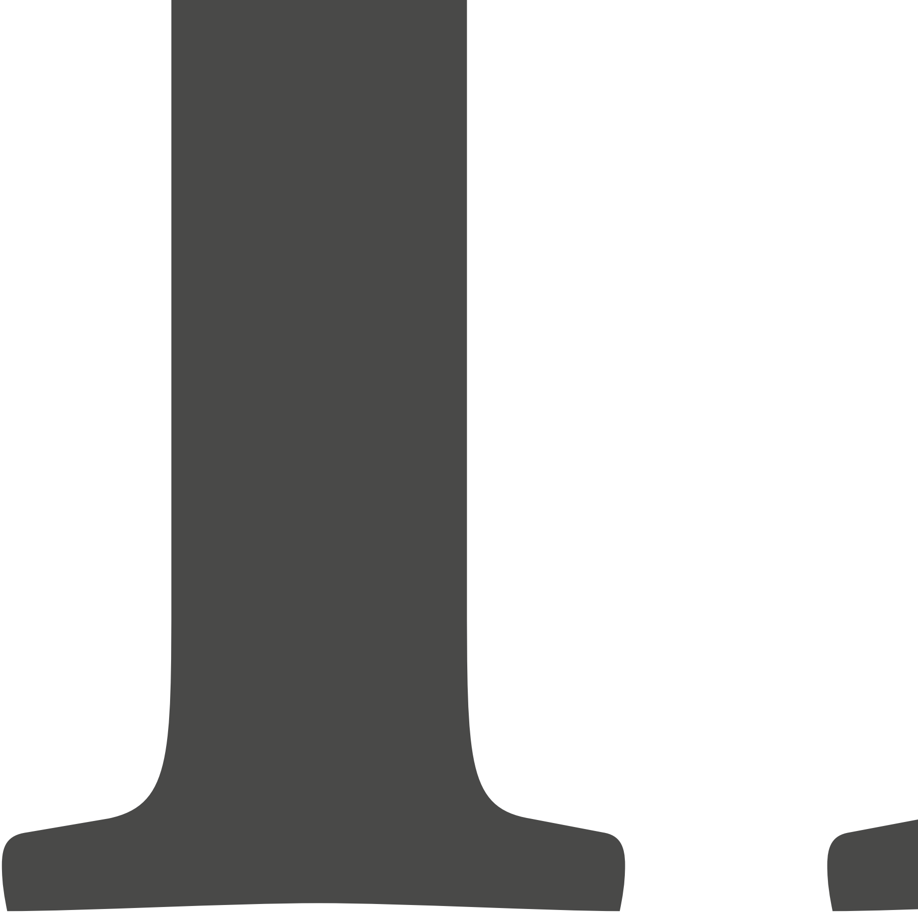
V

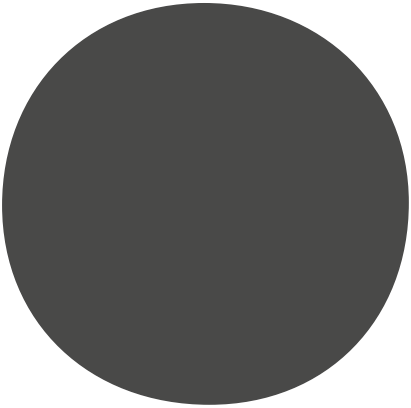
y



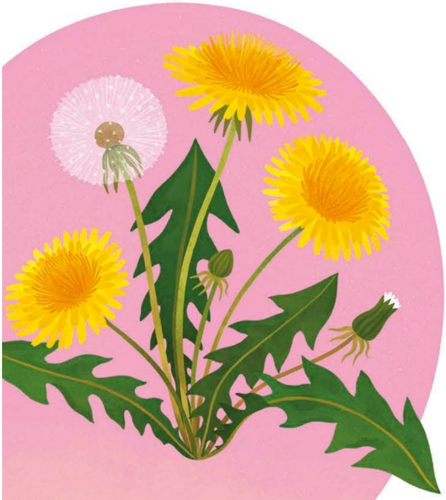


y





Dandelion



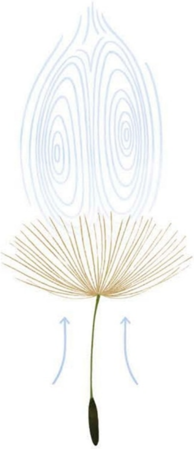
Common dandelion

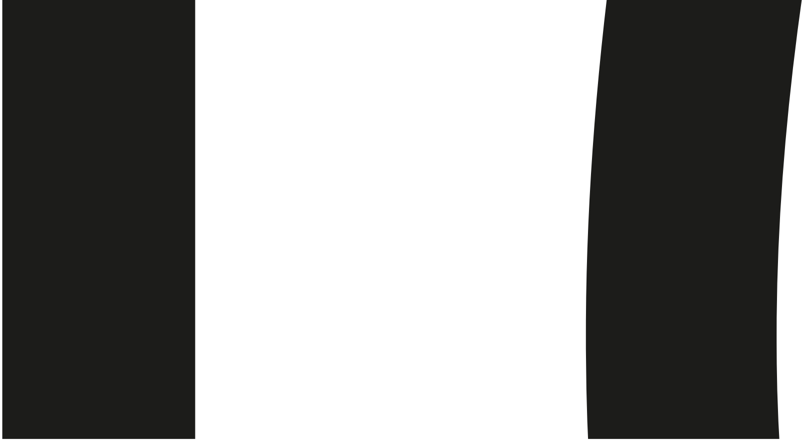
(Taraxacum officinale)

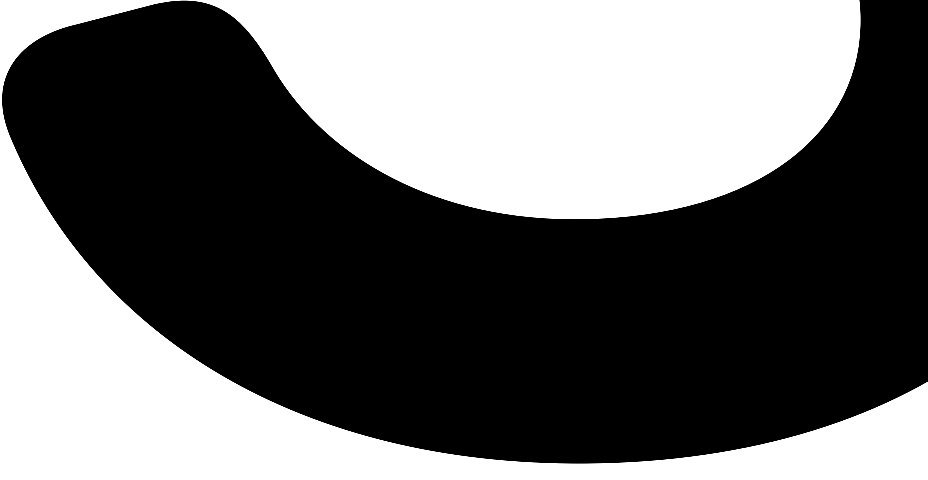
Dandelions can be seen across Asia and Europe, their original home. They have now spread to many other parts of the world.

Spinning air

When a dandelion seed takes off, zones of spinning air form above it. These are created by the hairs of the parachute. The spinning air has a lower pressure and slows the seed as it falls, so that it drifts further before touching down.







W

Z

it

O

h

th

f

([illegible]

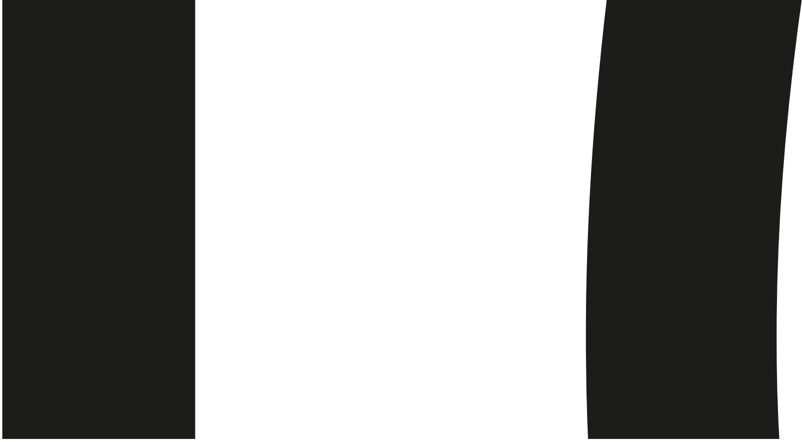
D

a

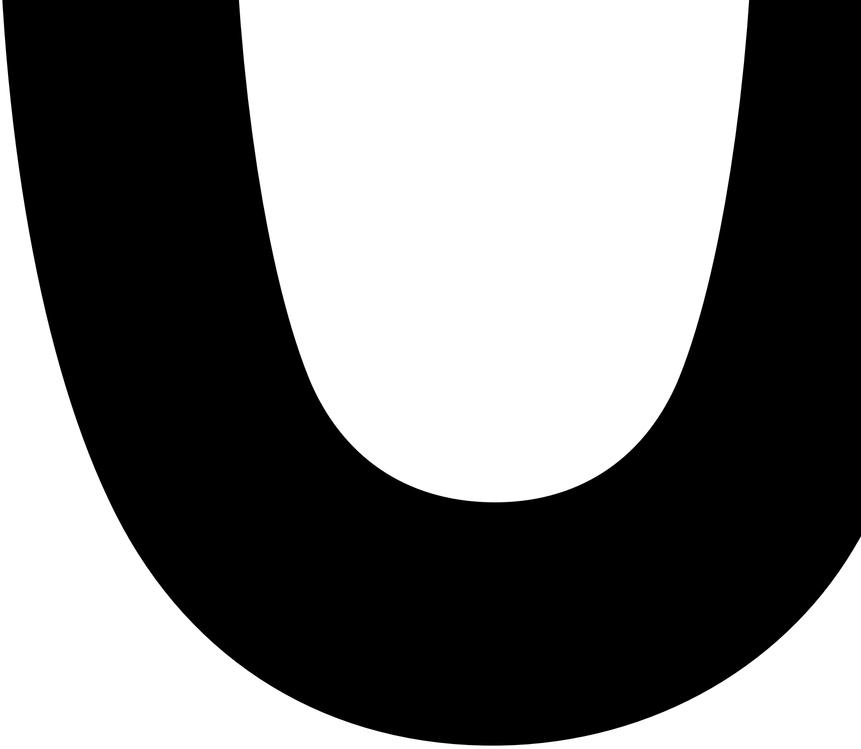
o

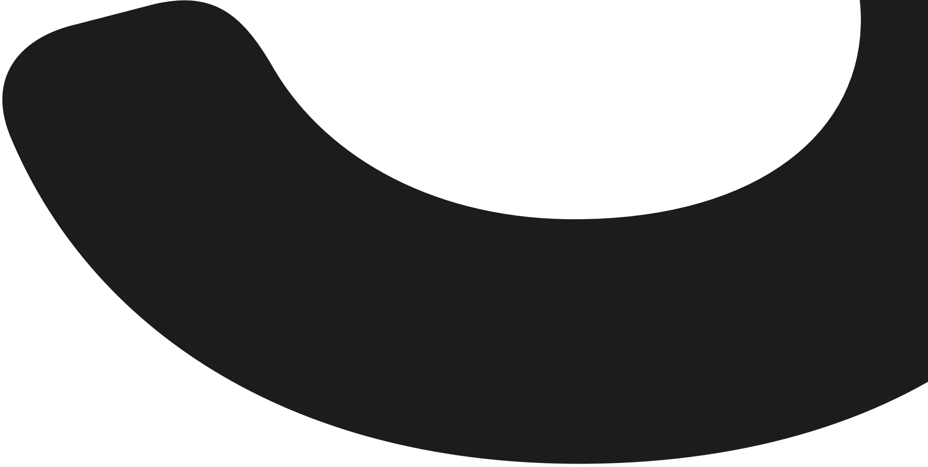
sp

p



[redacted]





D

p

g

W

n

in

C

In

a

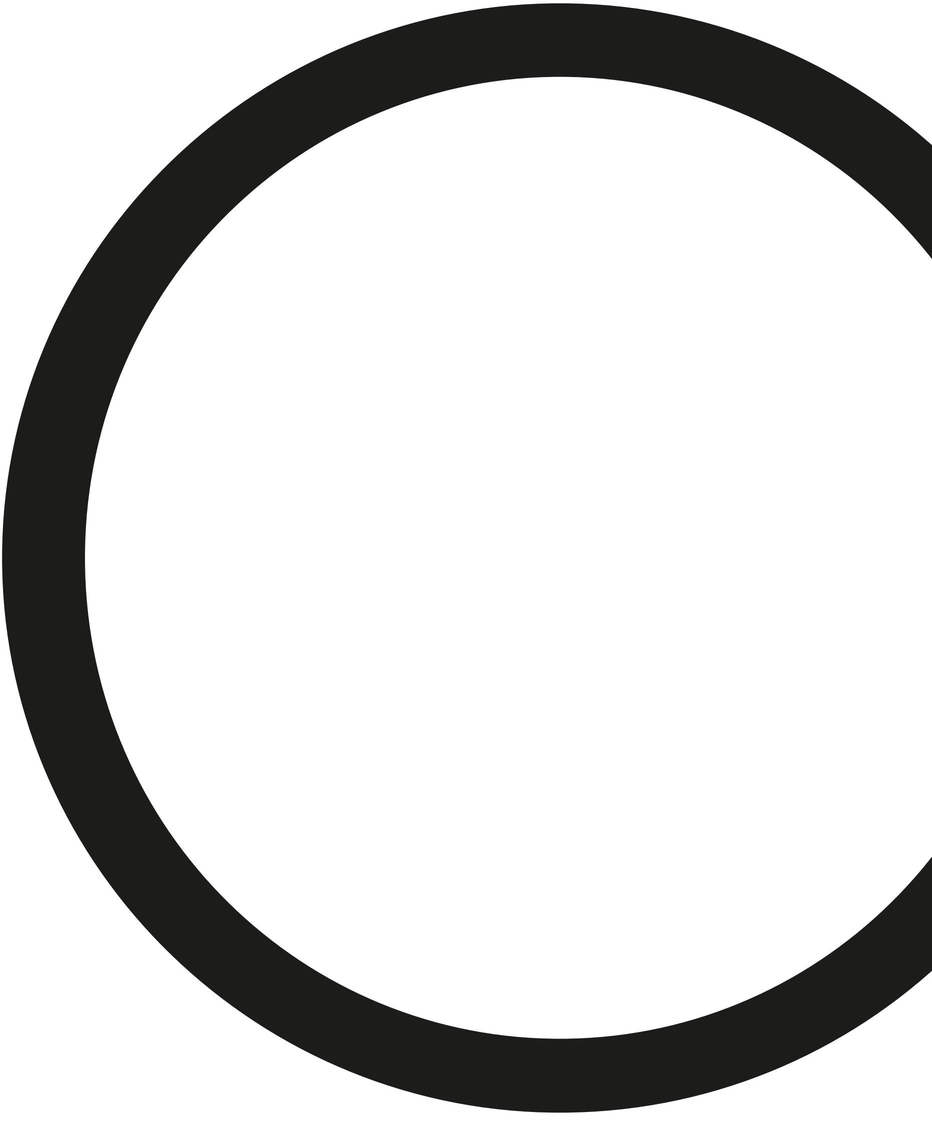
p

Si

T

h

a



p

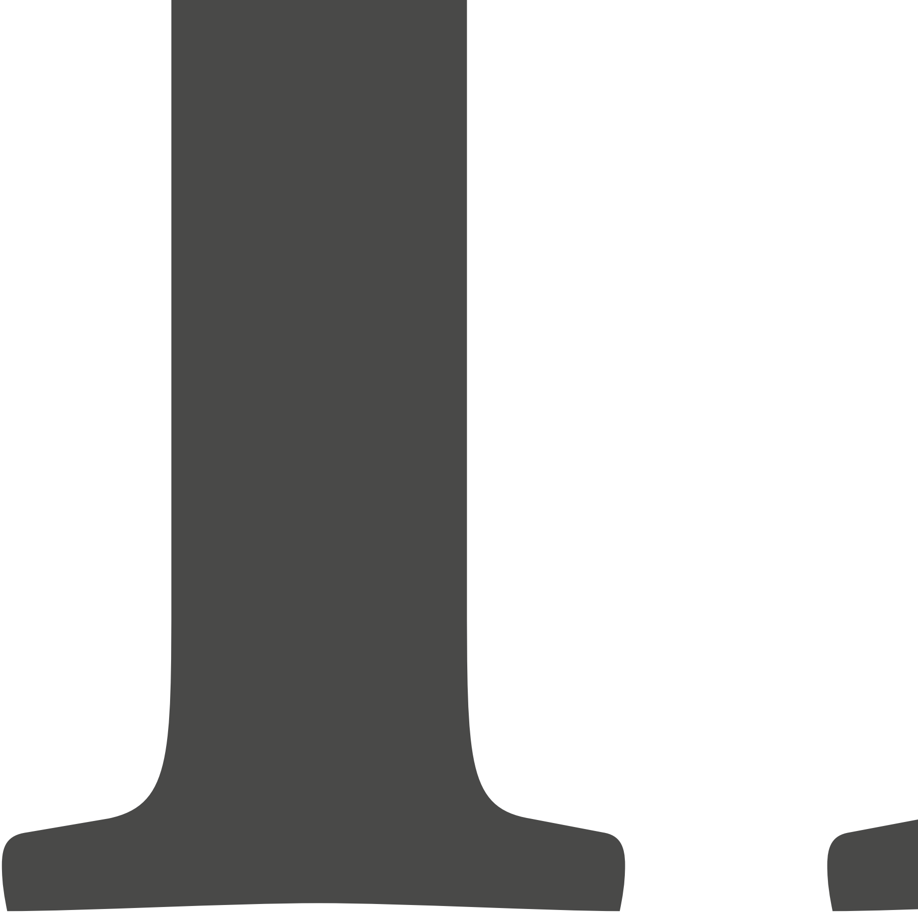
h

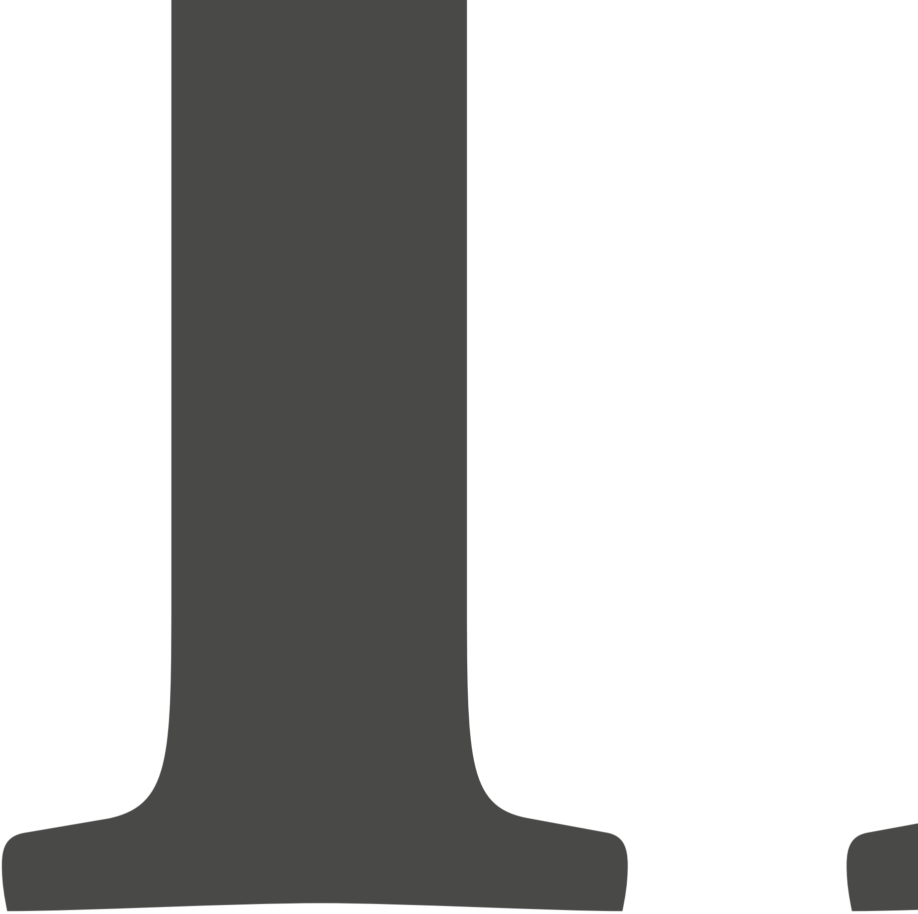
K

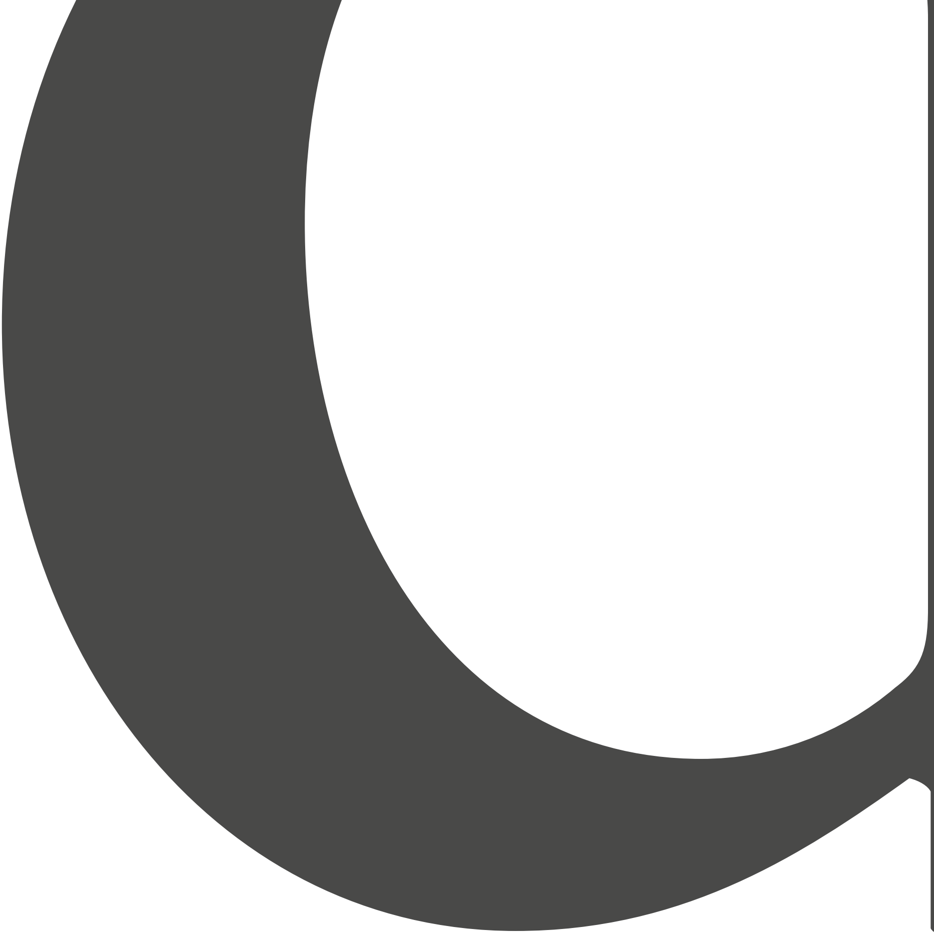
m

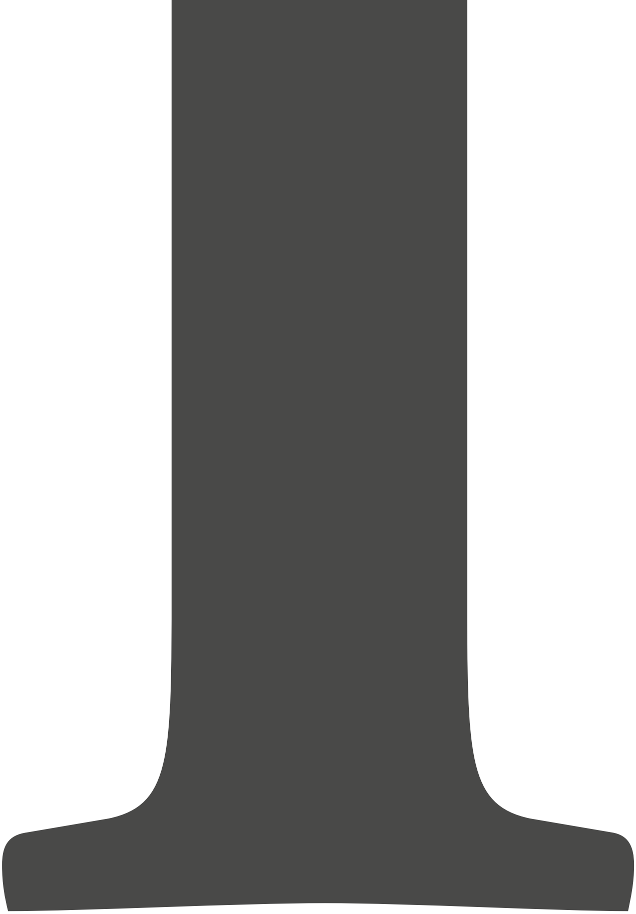
se

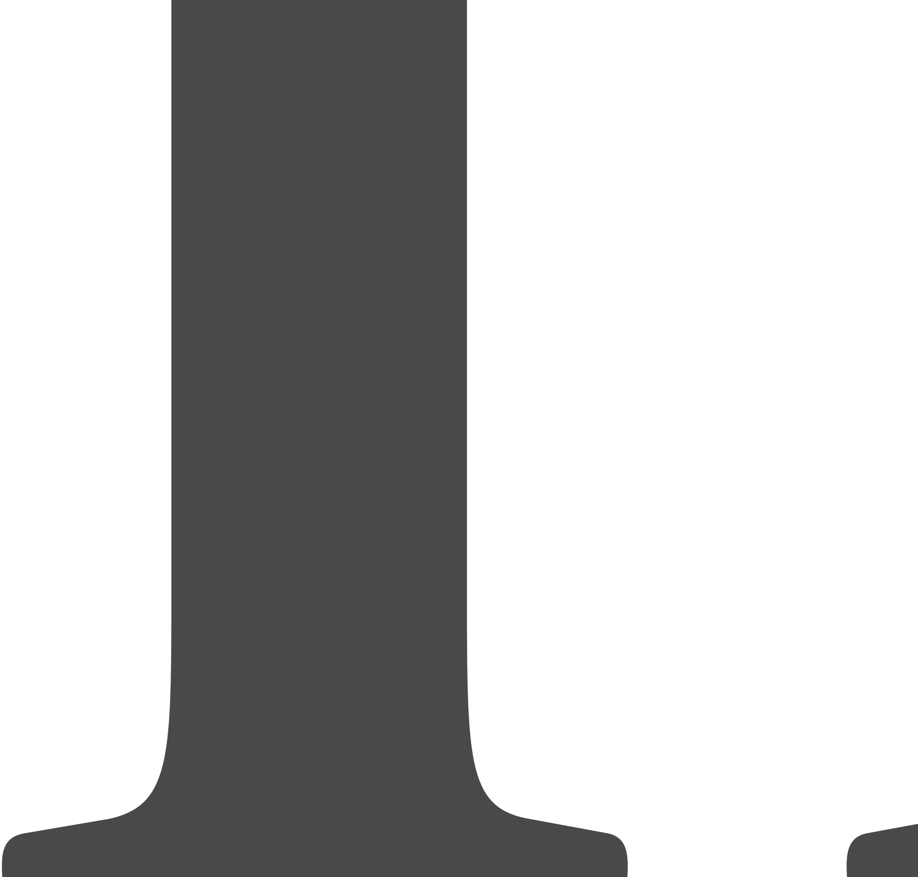
a

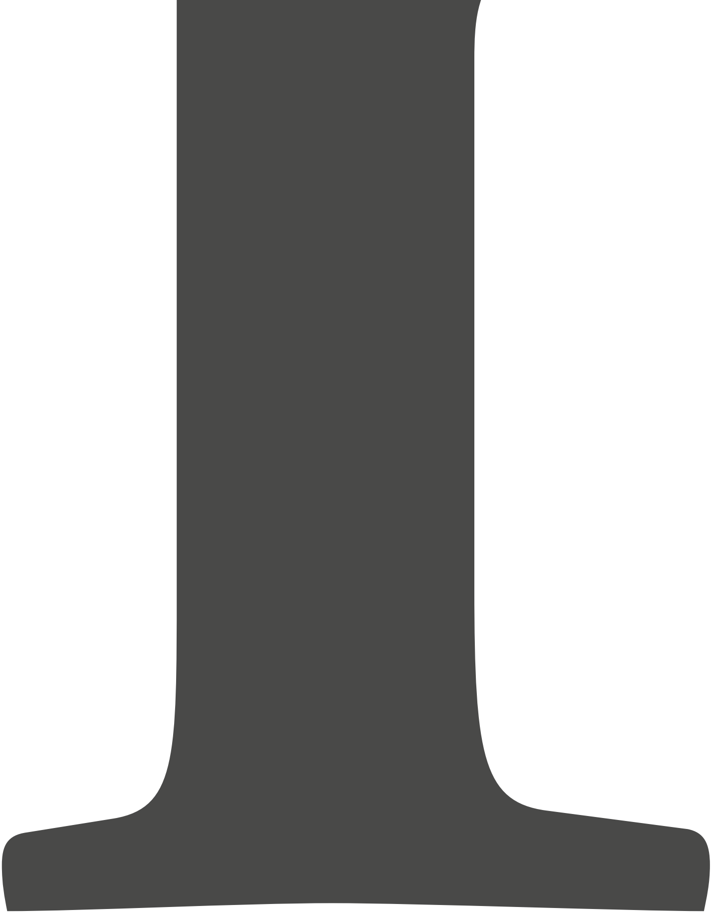




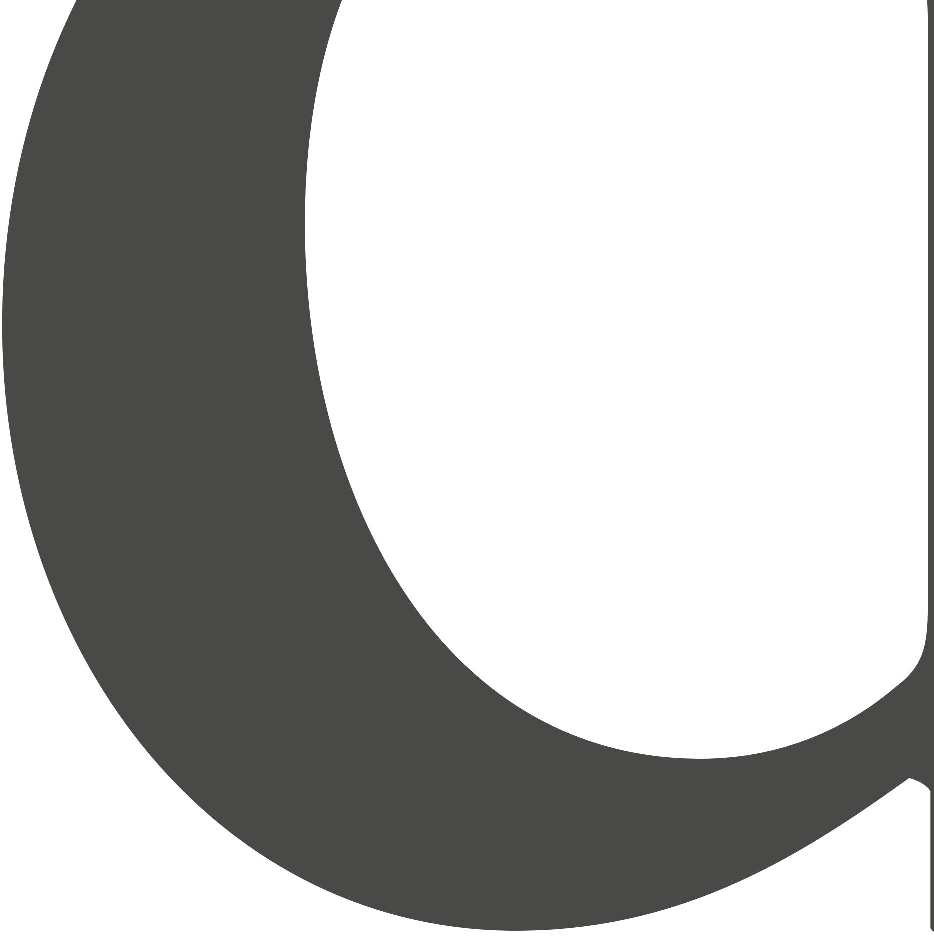


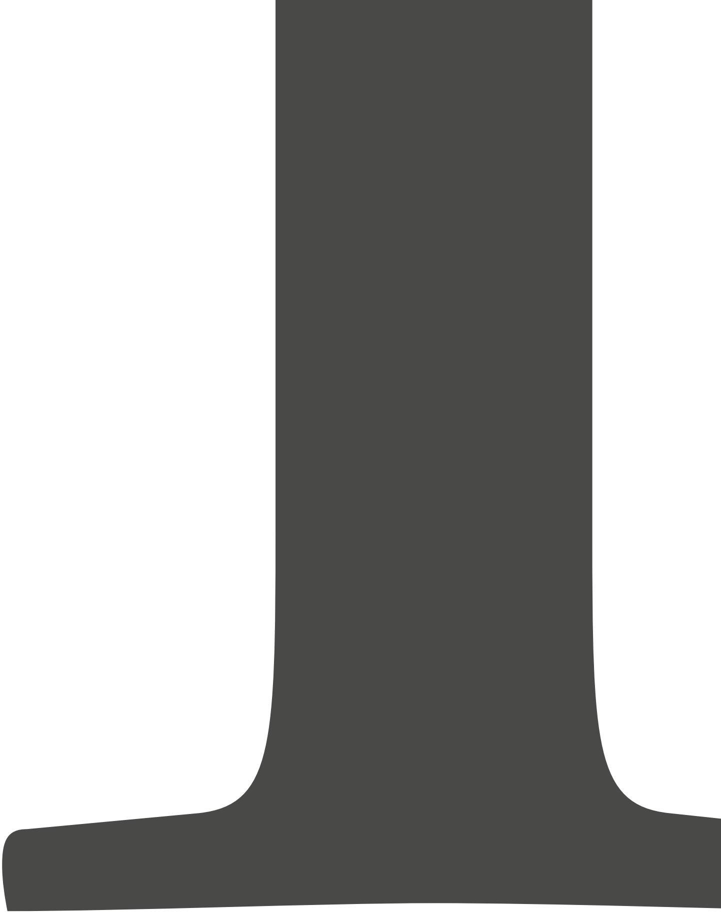


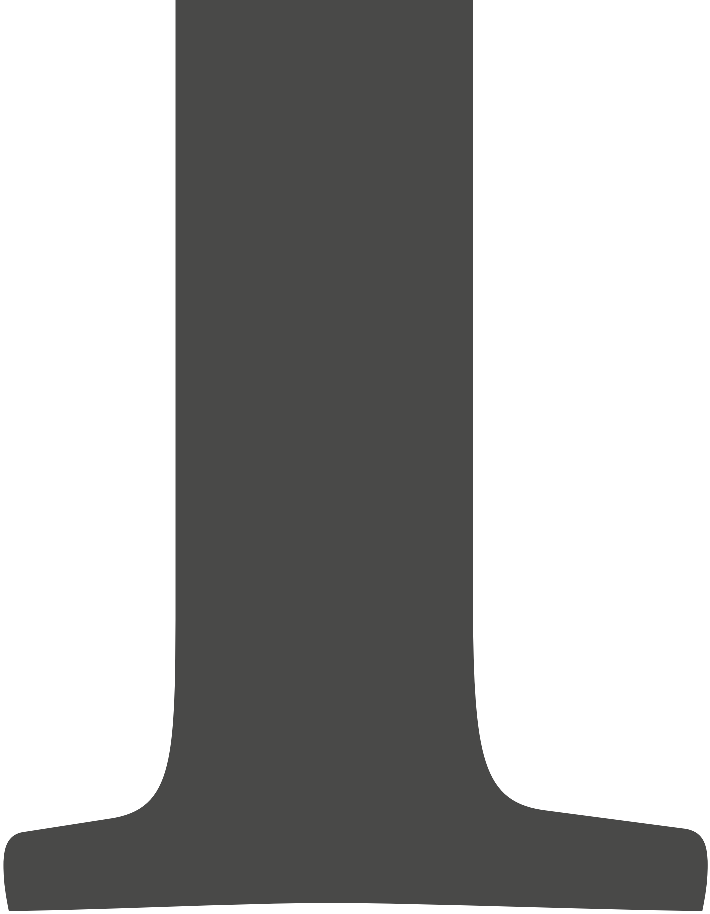


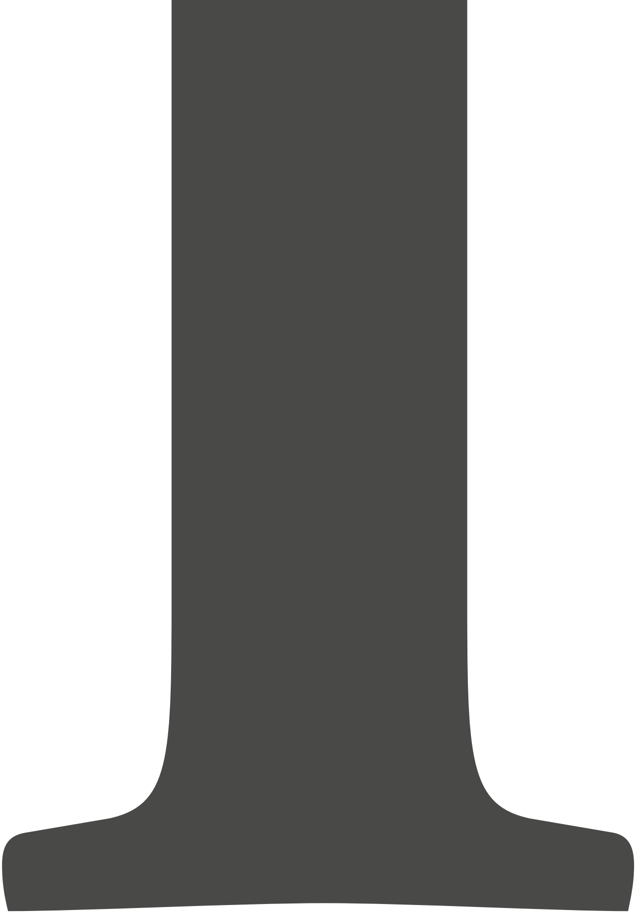


1

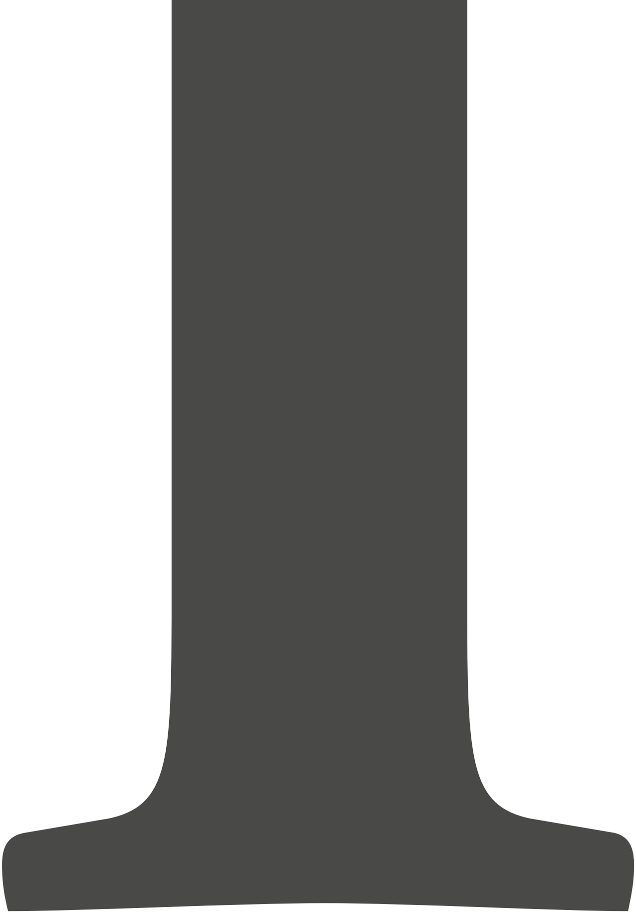


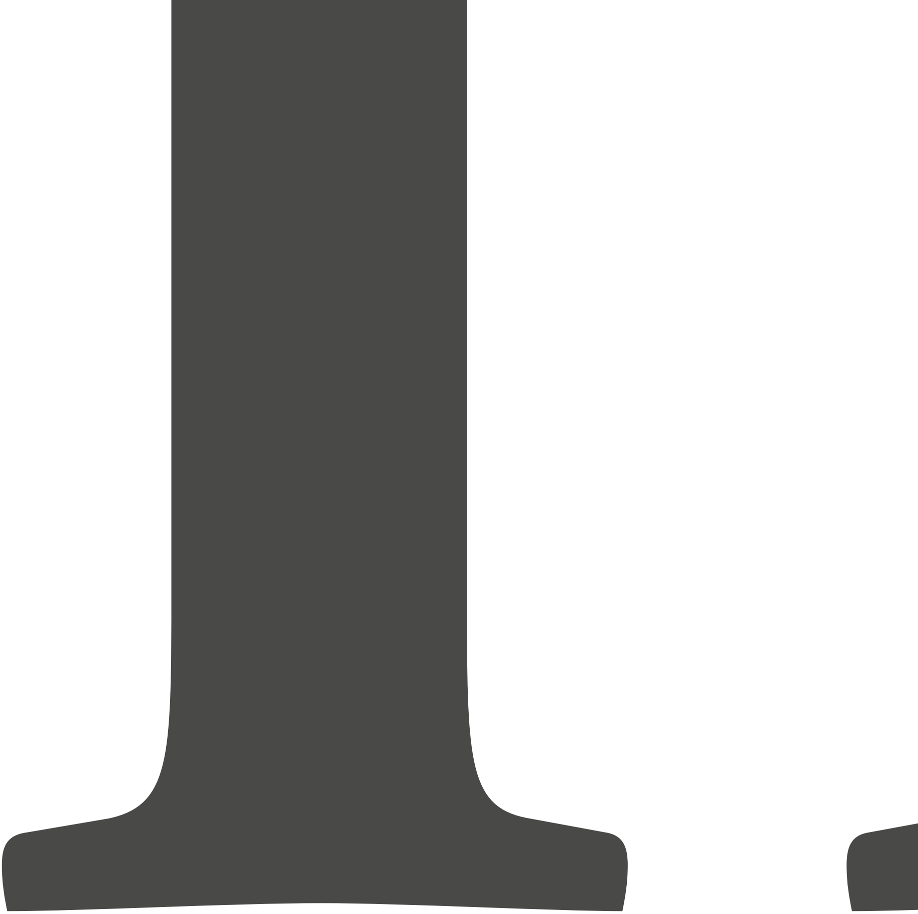


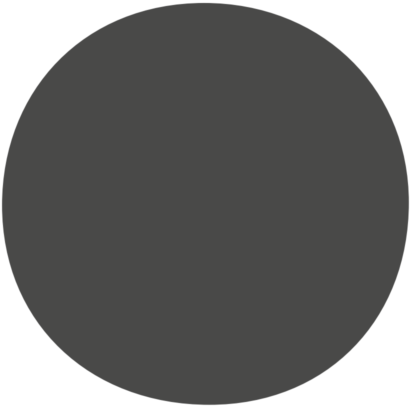


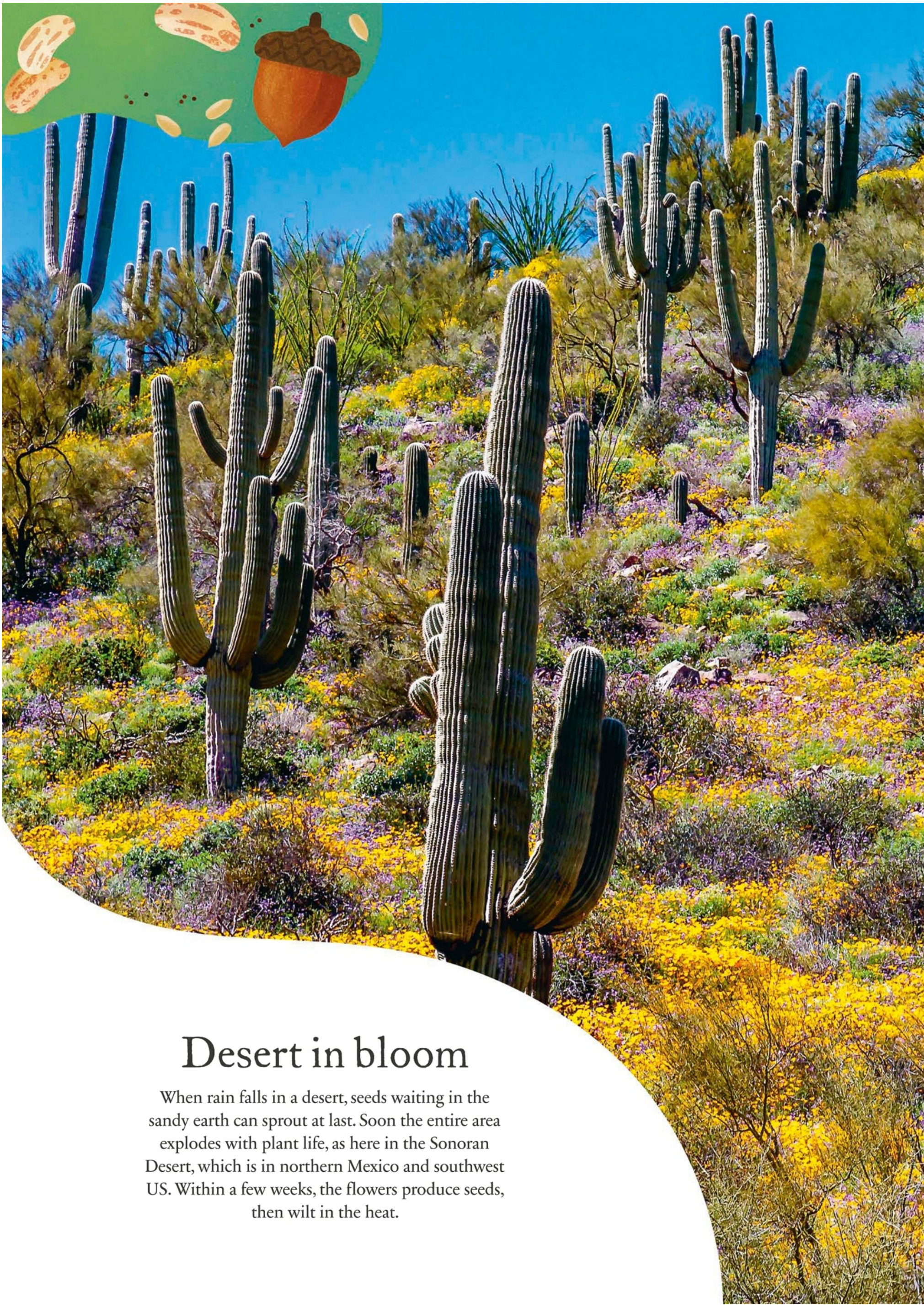


y



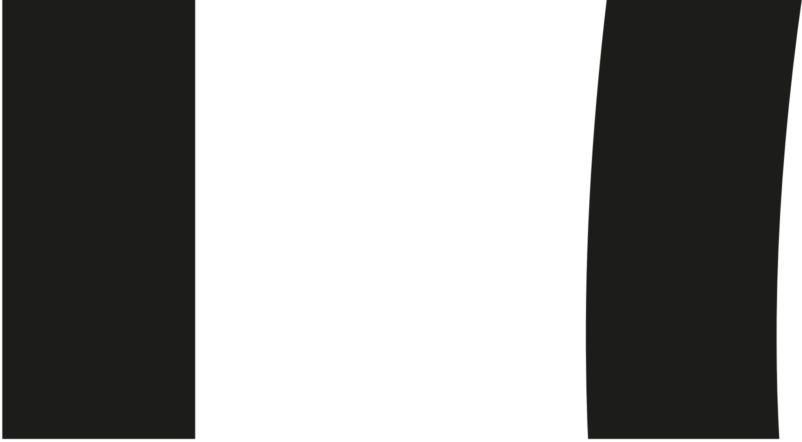


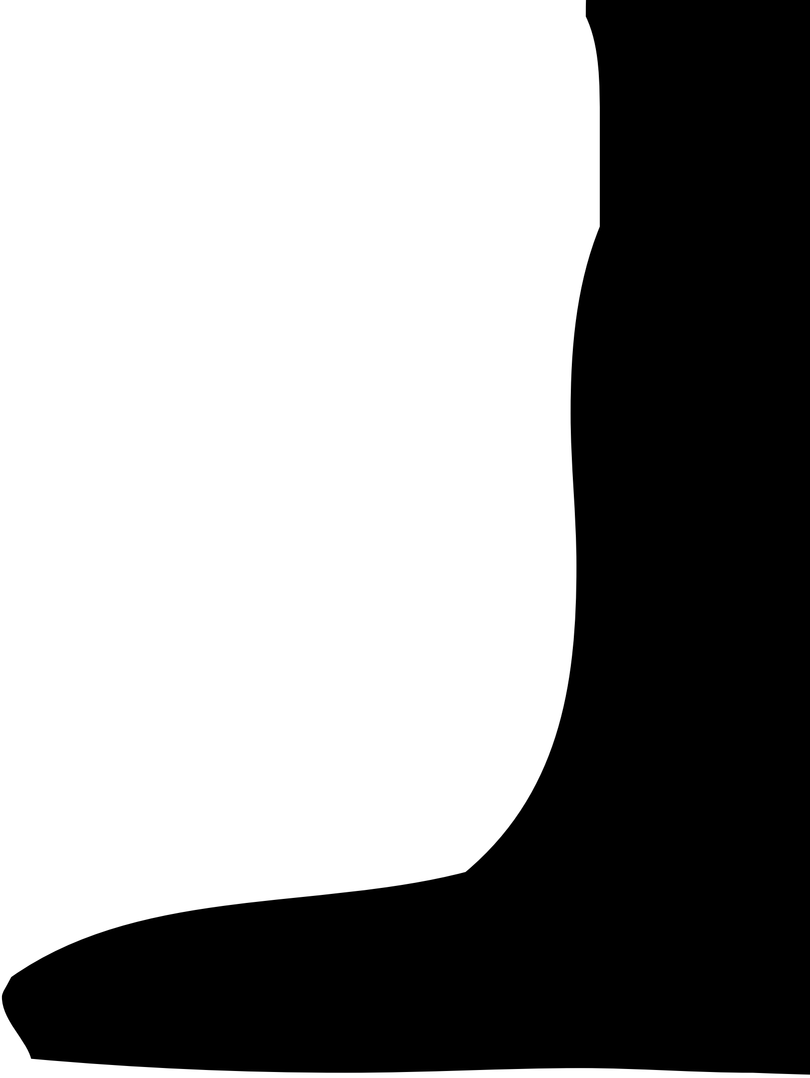


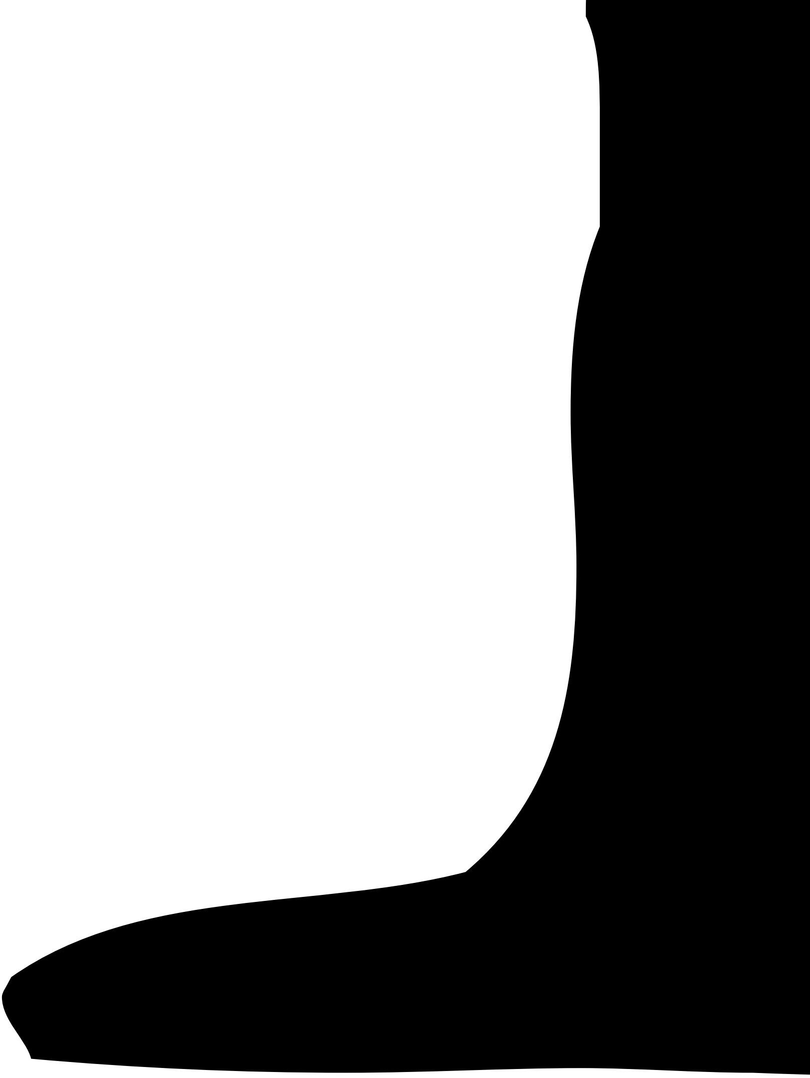


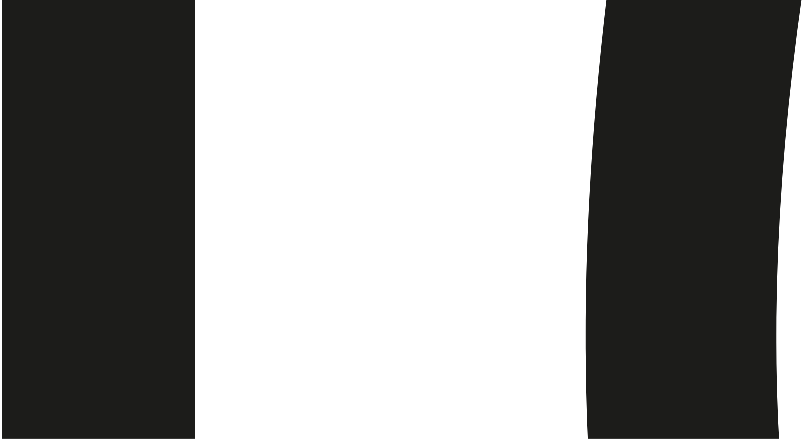
Desert in bloom

When rain falls in a desert, seeds waiting in the sandy earth can sprout at last. Soon the entire area explodes with plant life, as here in the Sonoran Desert, which is in northern Mexico and southwest US. Within a few weeks, the flowers produce seeds, then wilt in the heat.









H

th

T

st

b

T

p

e

C

f

Se

sp

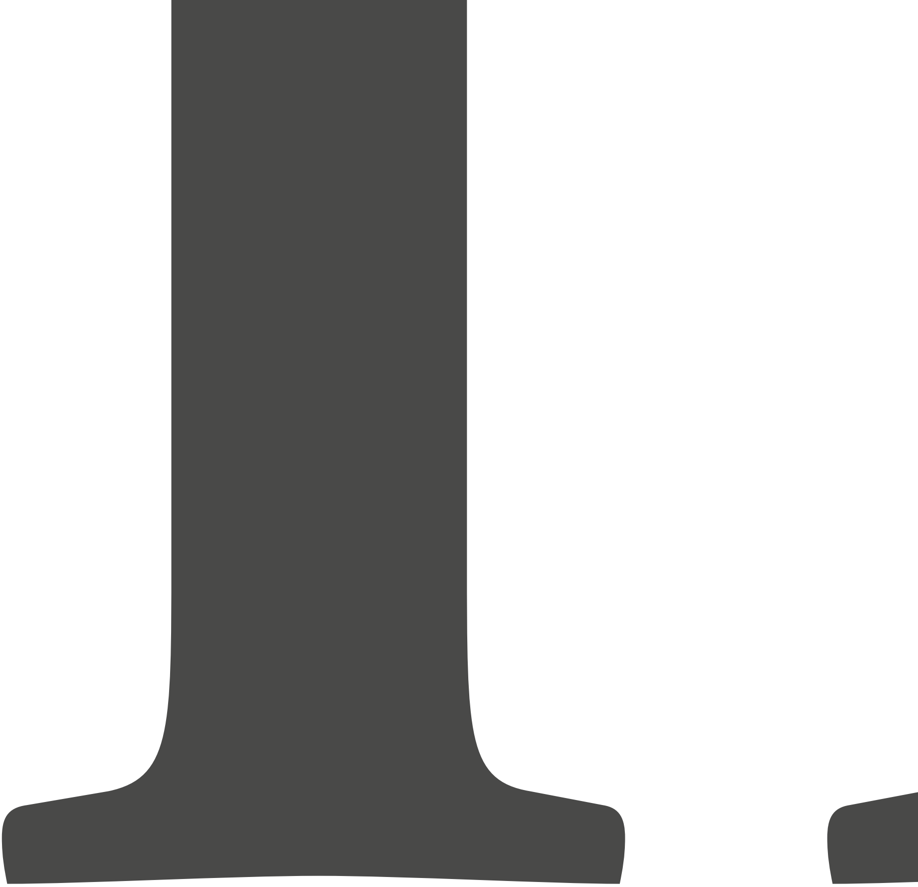
th

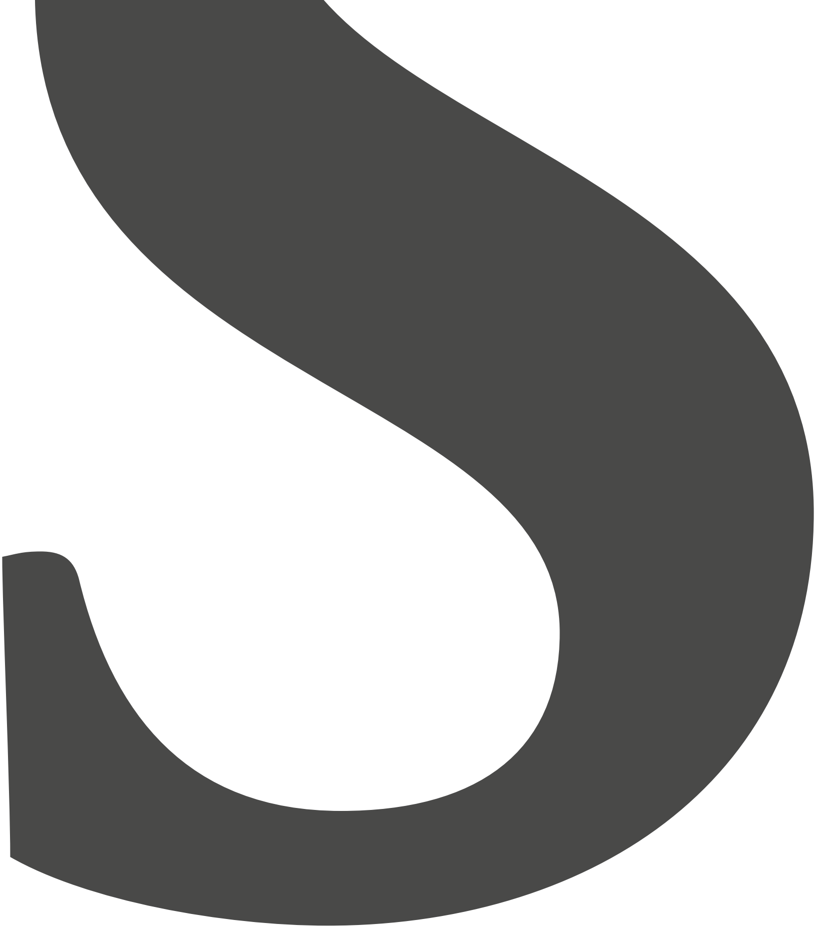
fr

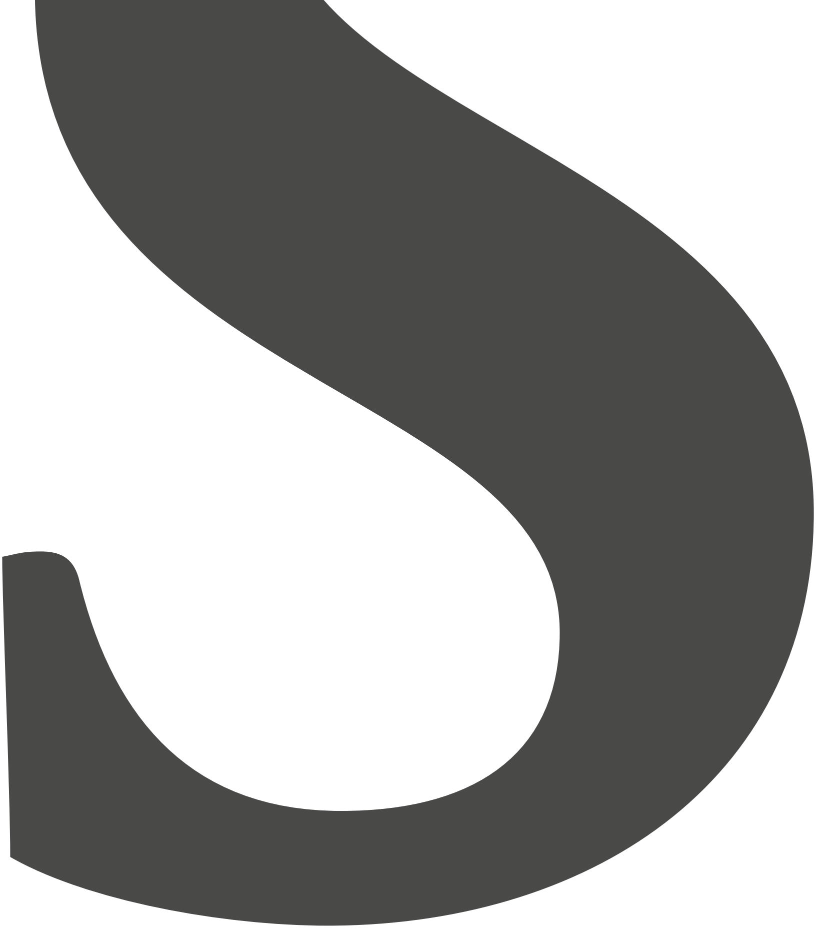
T

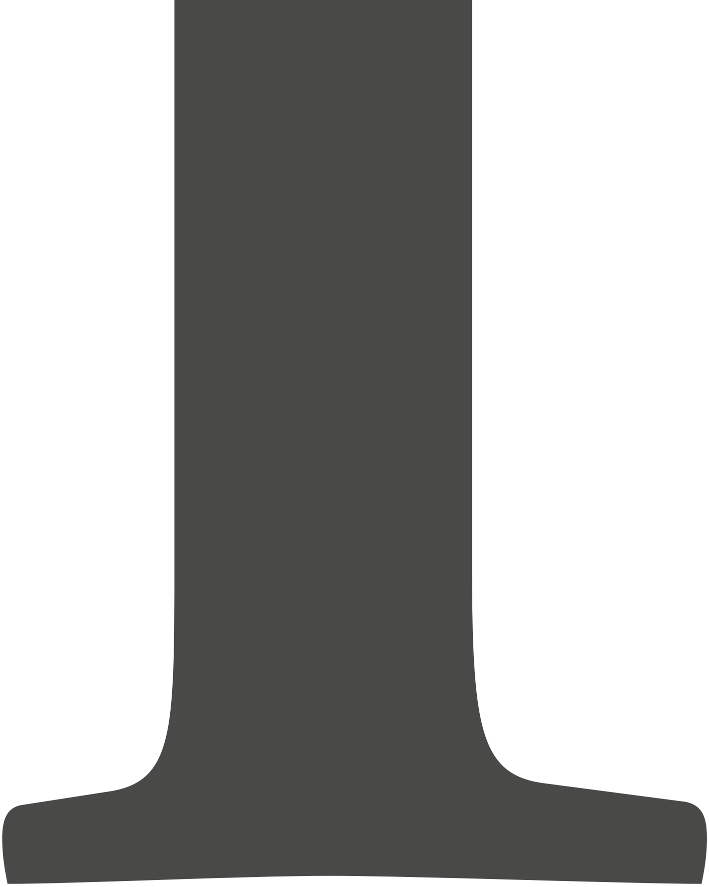
in

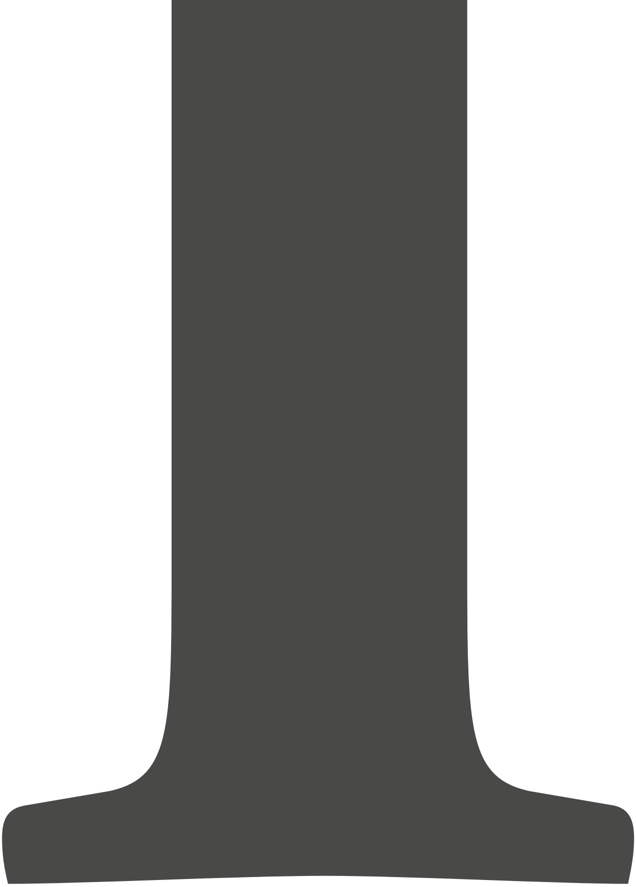
it

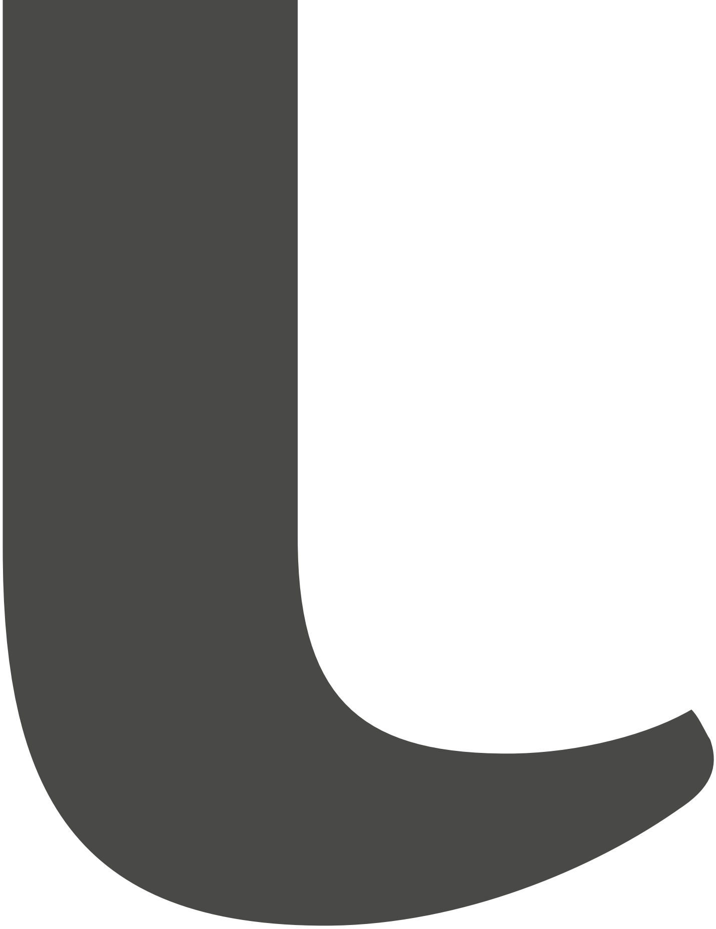


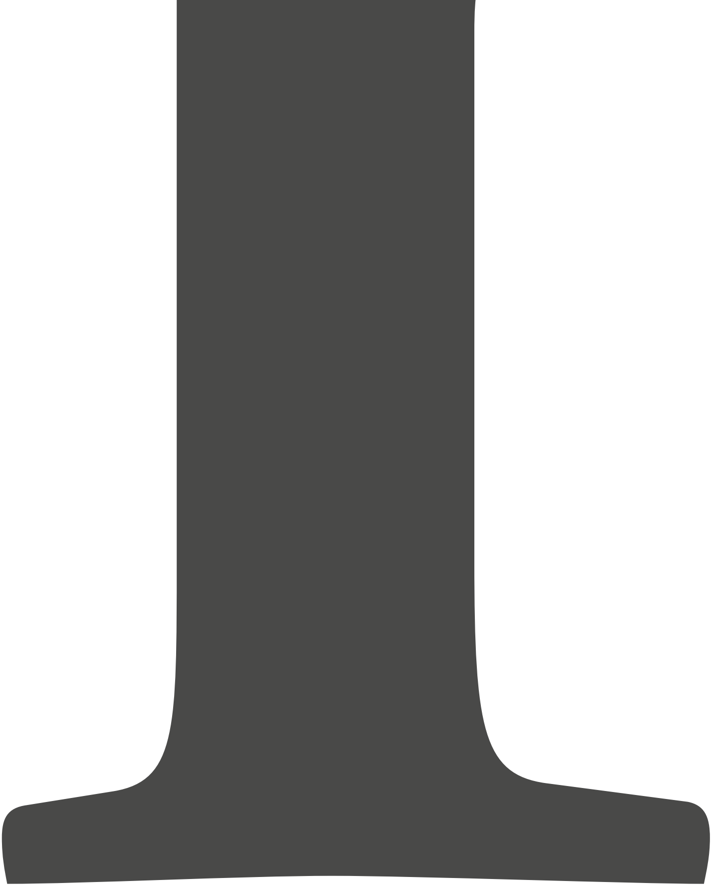


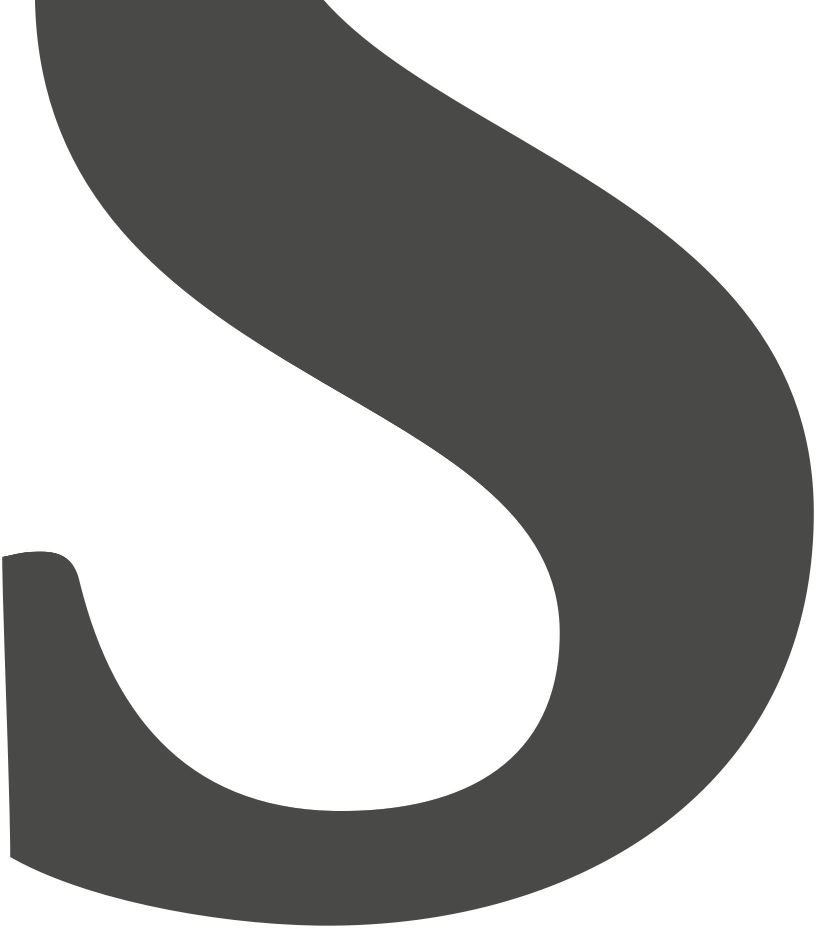




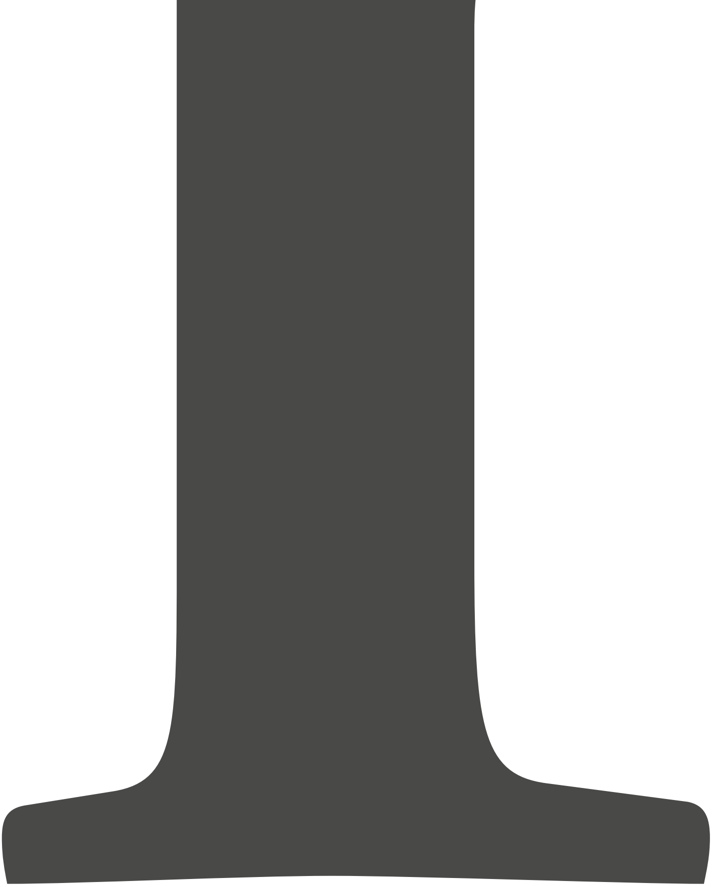


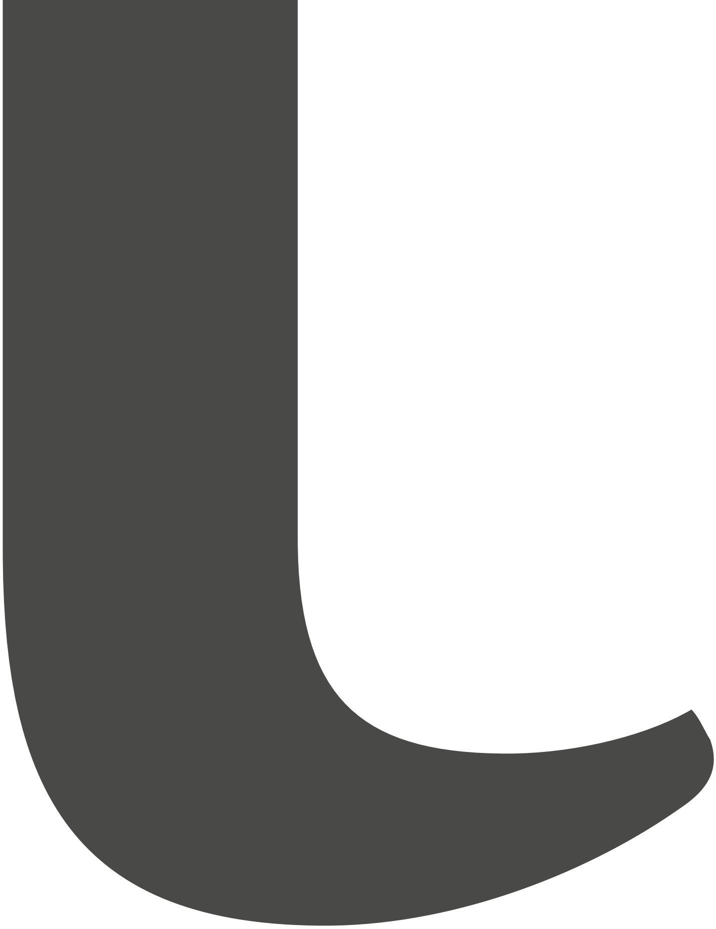


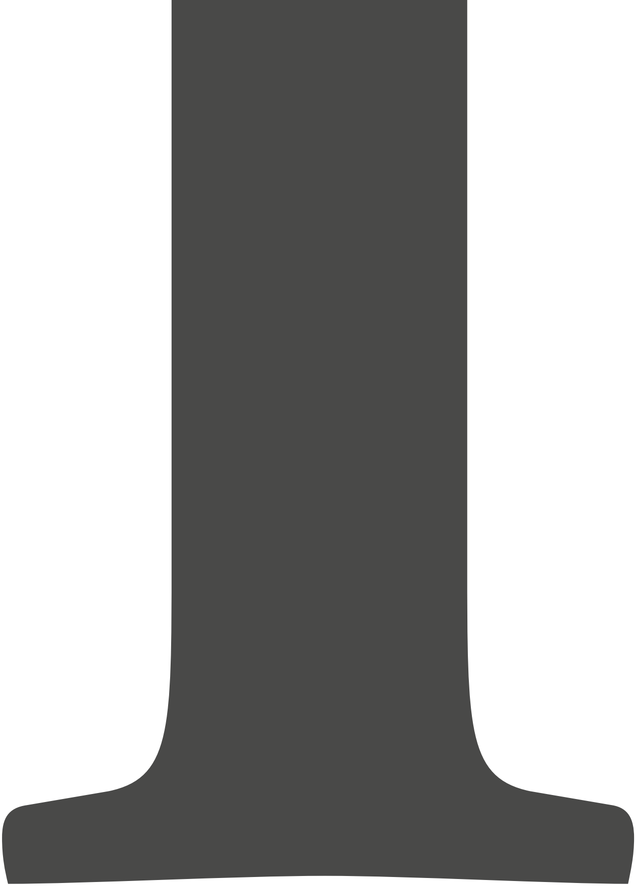


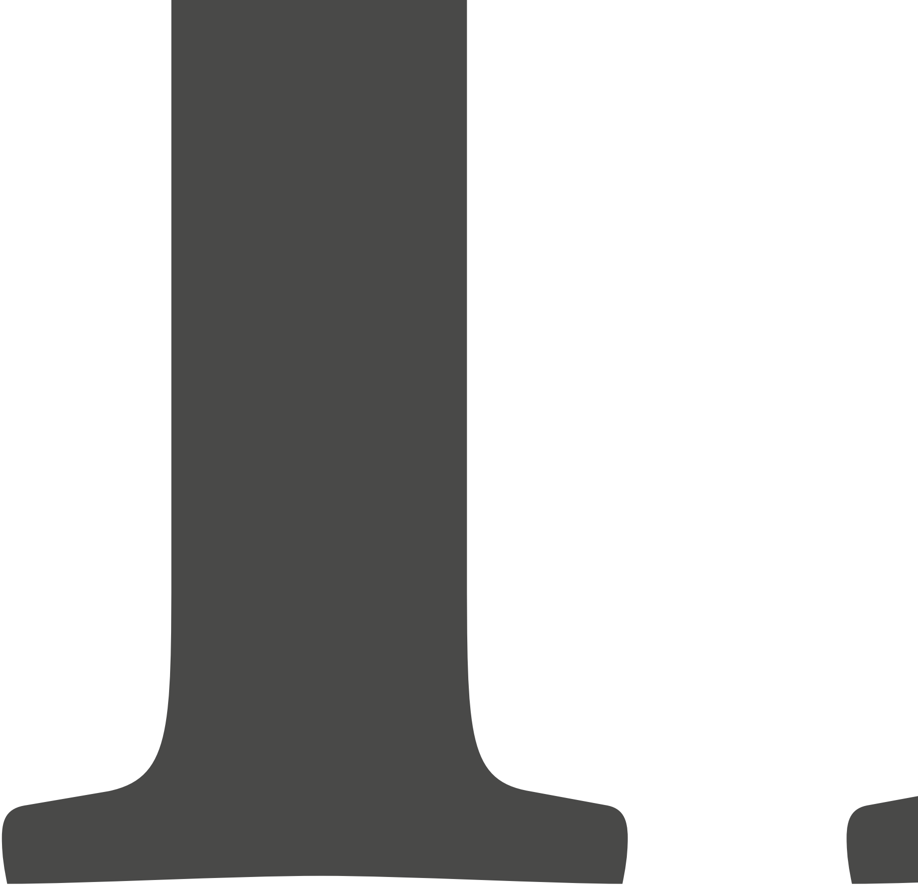


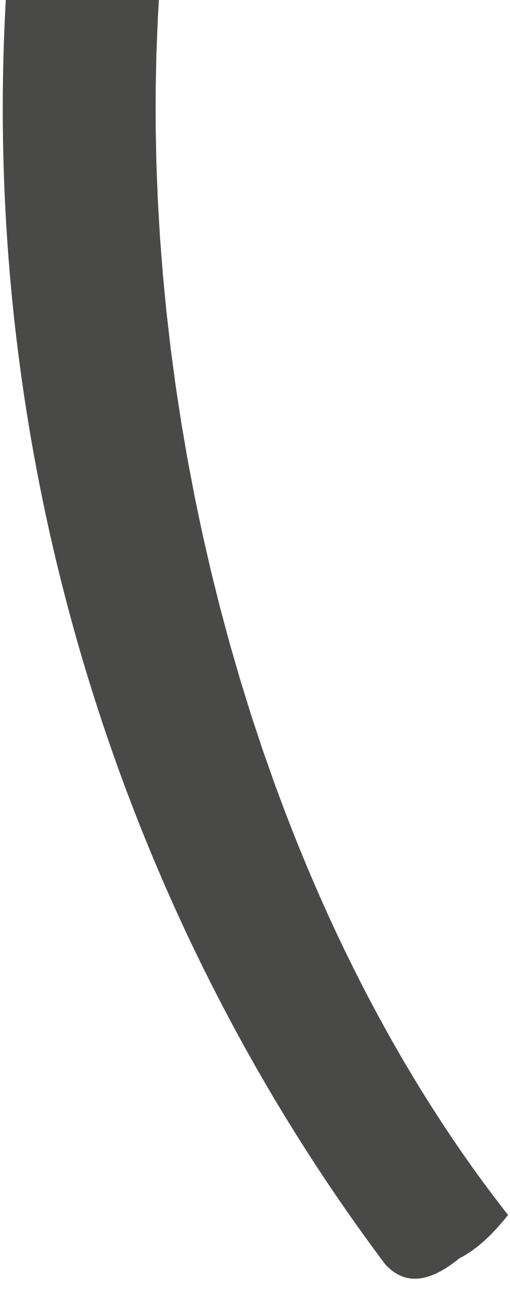
a

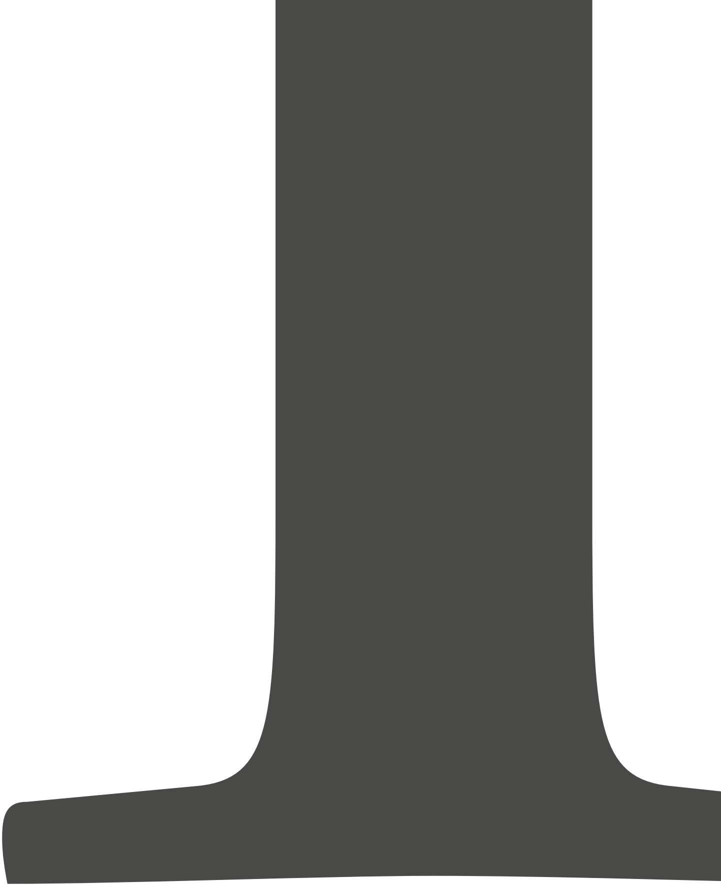


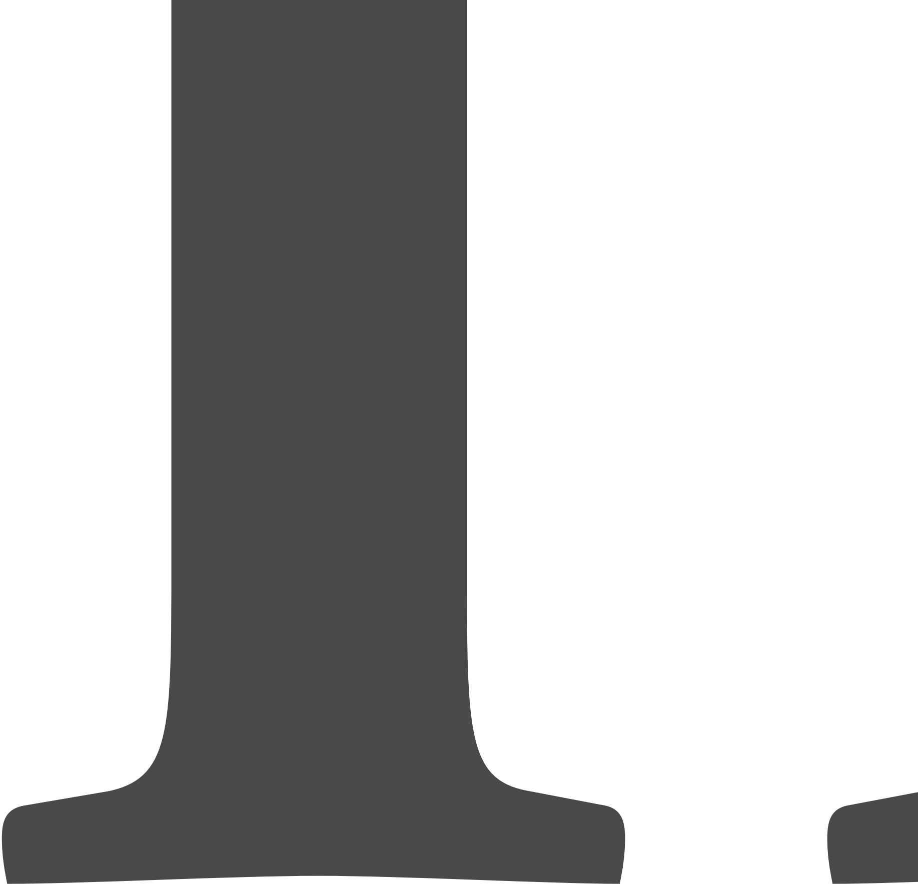


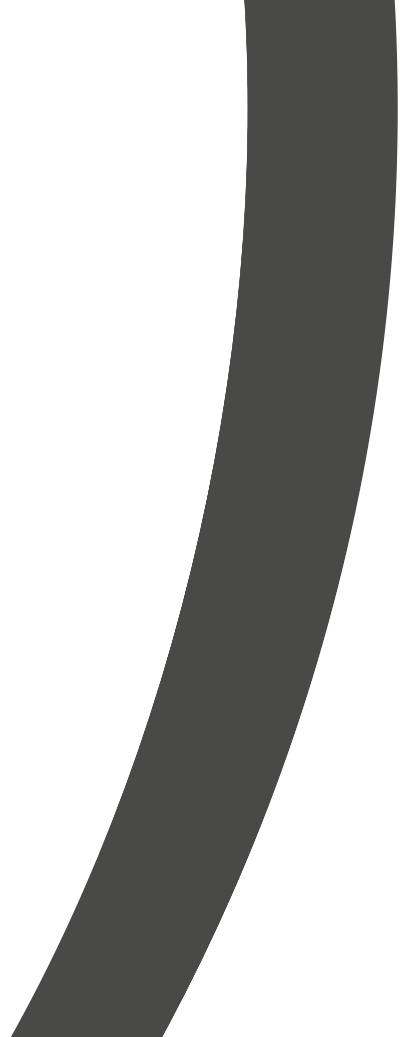


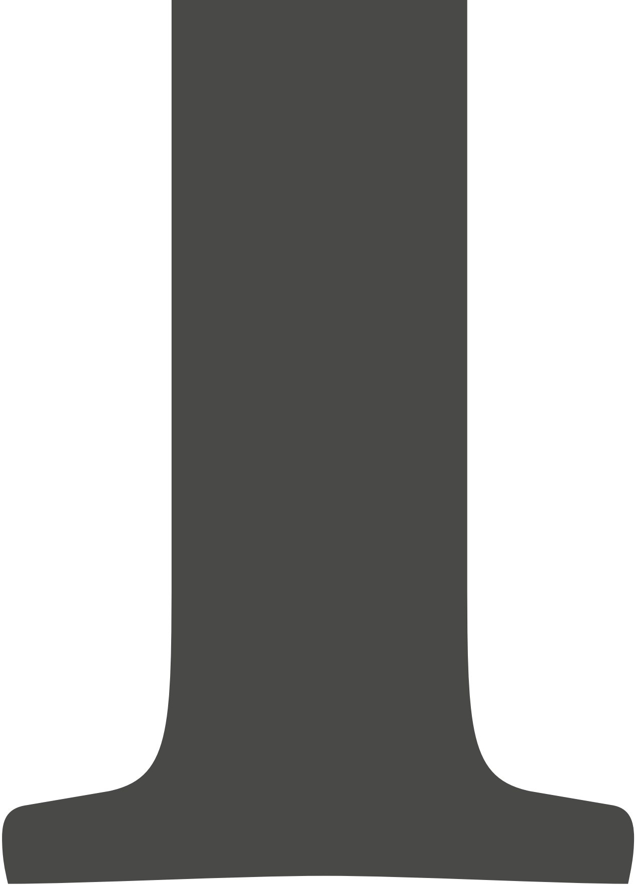


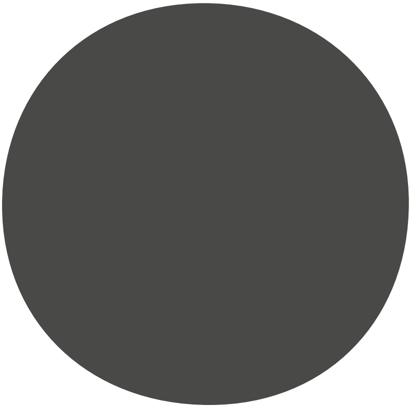




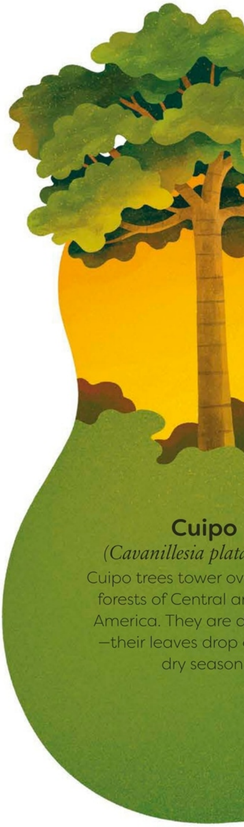








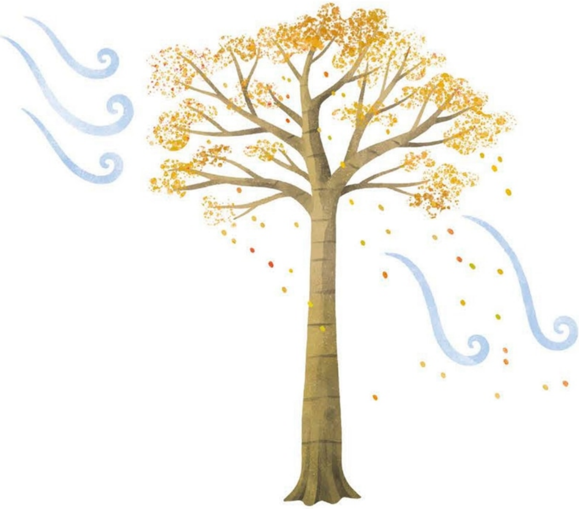
Cuipo tree



Cuipo

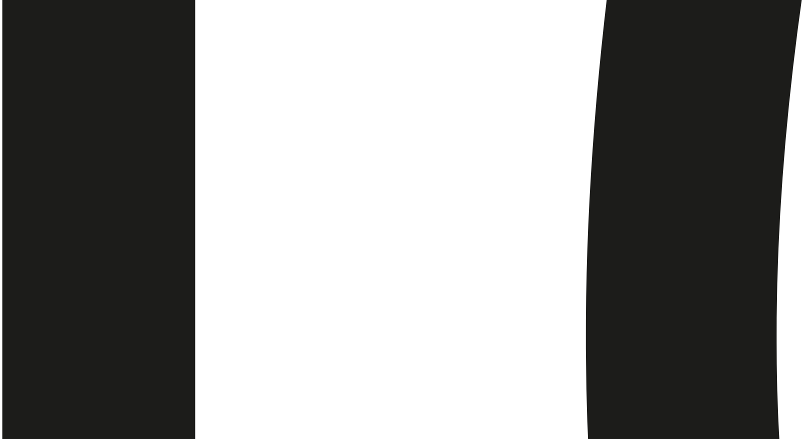
(Cavanillesia plata

Cuipo trees tower ov
forests of Central ar
America. They are c
—their leaves drop
dry season



Carried on the wind

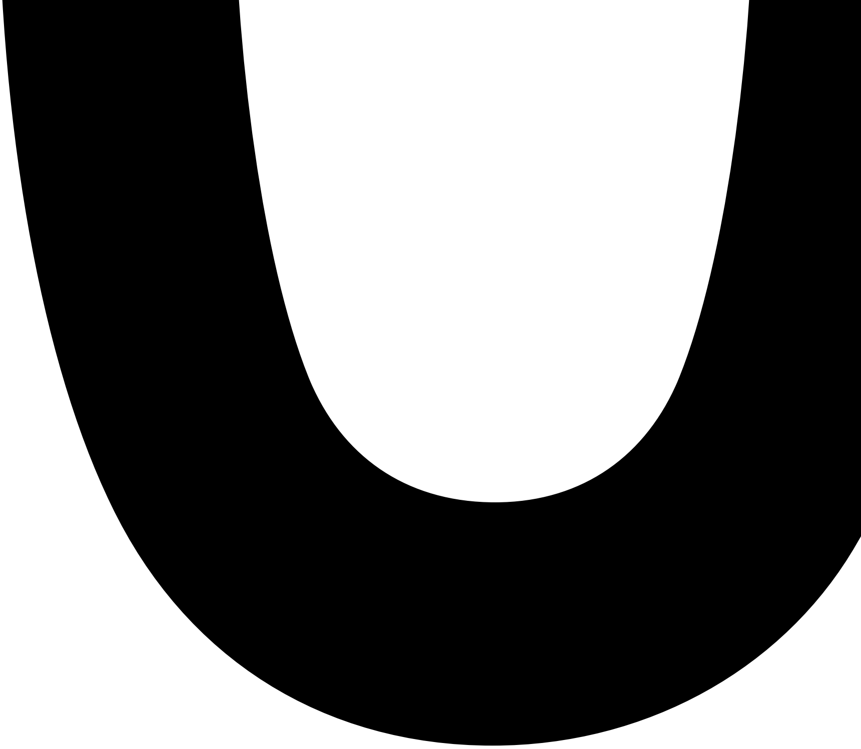
Most rain forest trees use animals to spread their seeds, but cuipo trees gr high above the rain forest canopy where the wind can easily reach ther They produce some of the largest winged seeds in the world, which are carried far away from their parent as they fall.



U

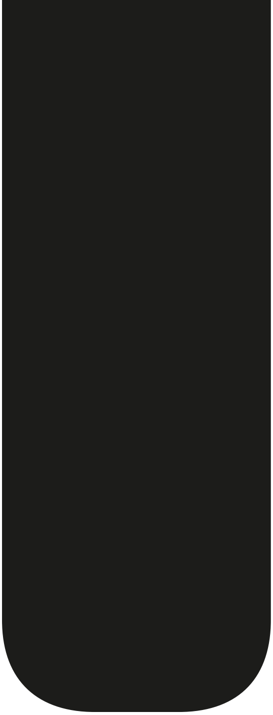
[redacted]

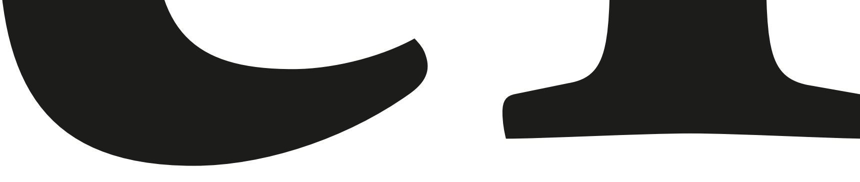
[redacted]



[redacted]

L





M

sp

h

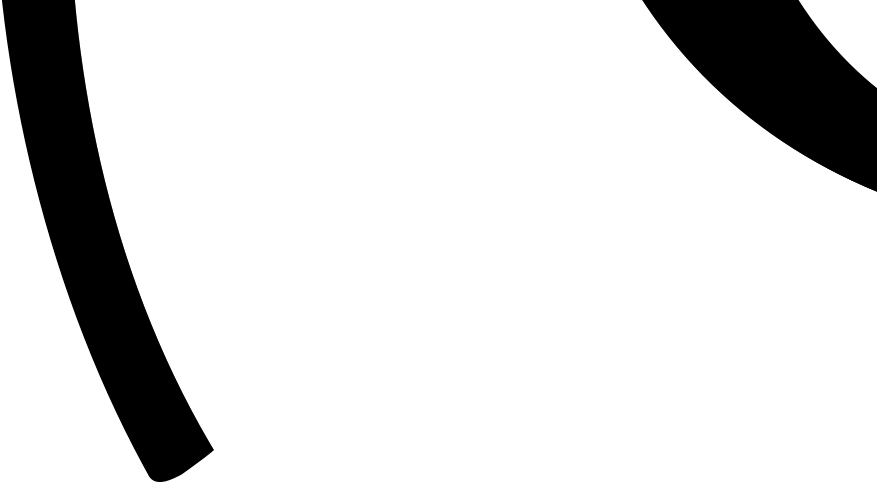
w

T

W

C

a

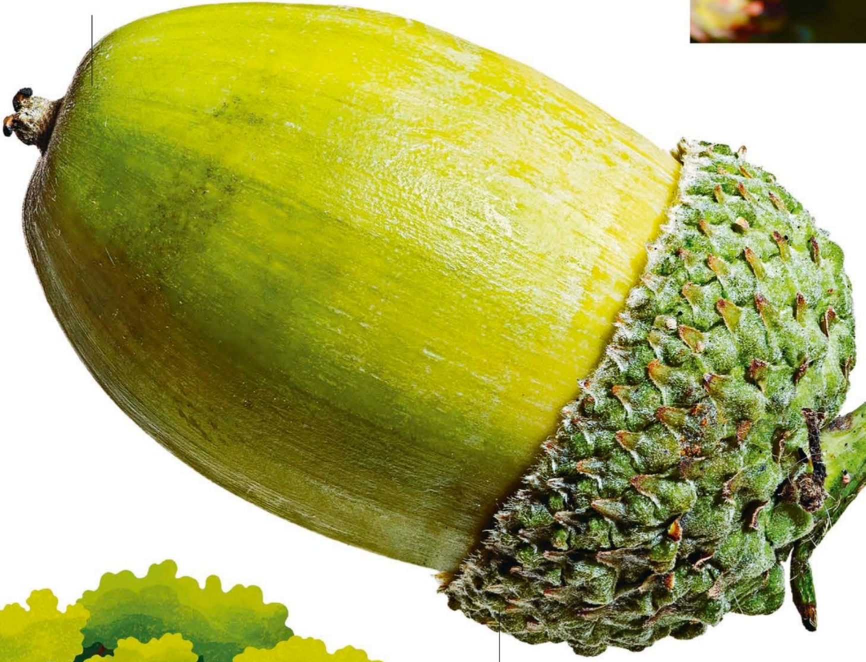


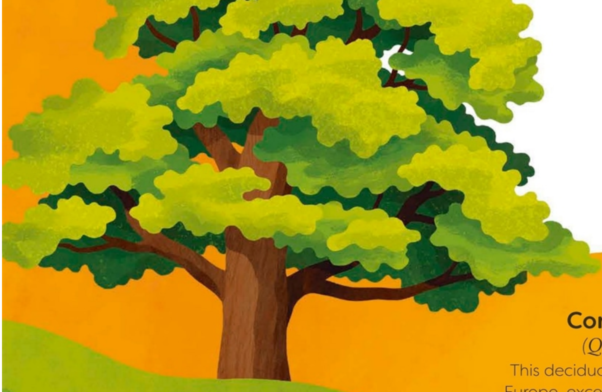
C

fo

A

d

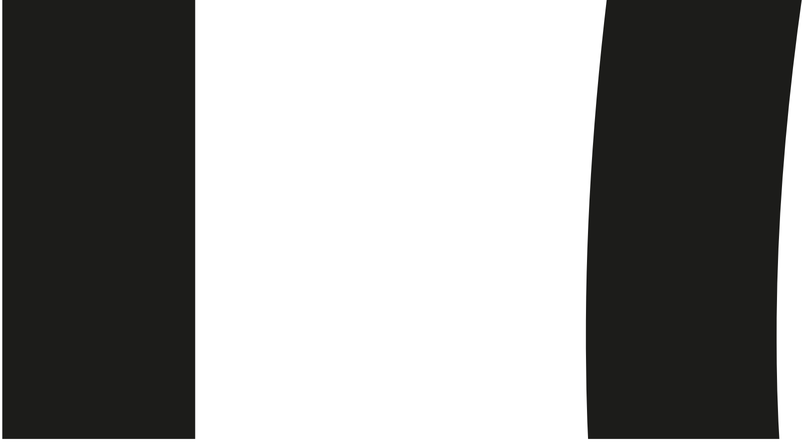




Common oak

(Quercus robur)

This deciduous tree lives in most of Europe, except the north and south. Its acorns and wavy-edged leaves help to tell it apart from other trees.



(<

T

E

lt

h

S

W

a

n

a

d

fe

E

a

C

in

A

g

b

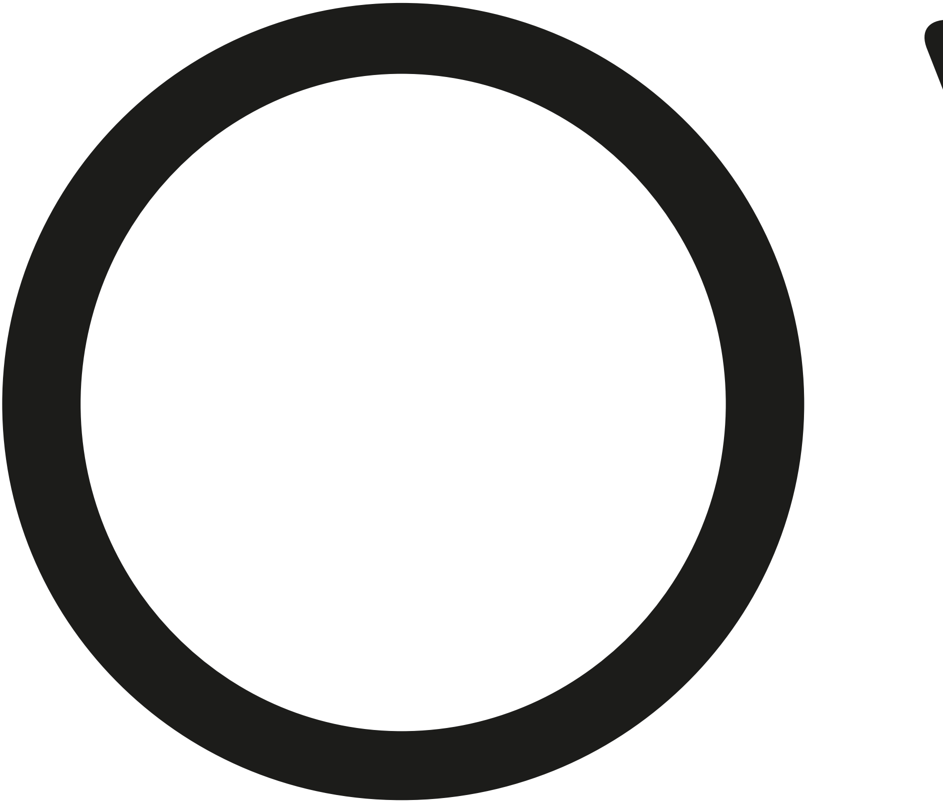
N

W

th

h

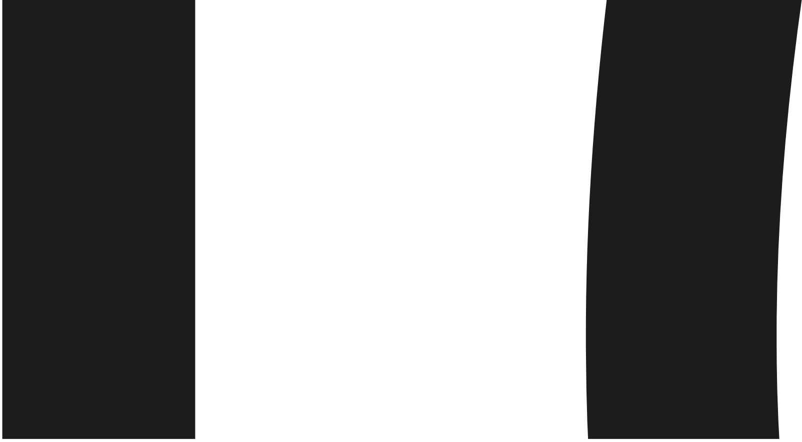
tr

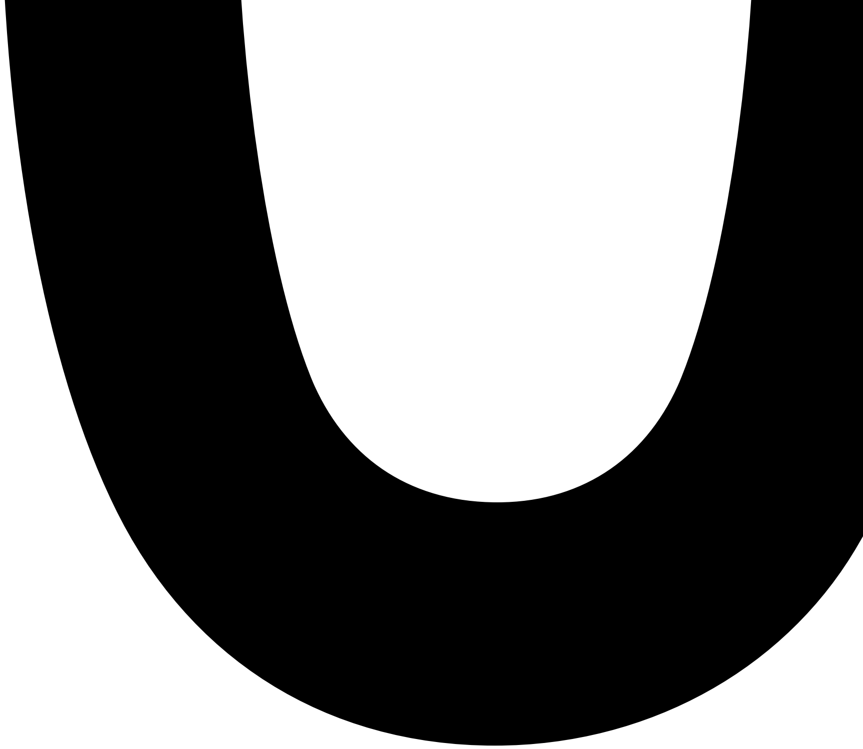


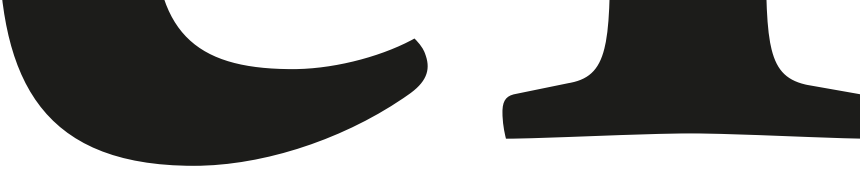
Oak

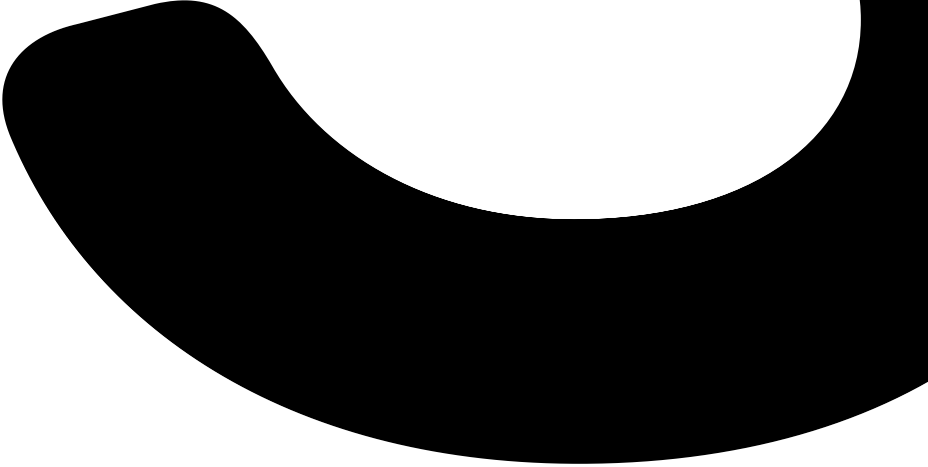
Storing acorns

The Eurasian jay gathers up to 5,000 ripe acorns in the fall and stores them in many different places. It relies on a kind of mind map to remember where its hiding places are, but always misses some acorns, which sprout the following spring.









T

a

d

m

a

sp

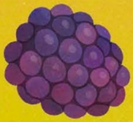
E

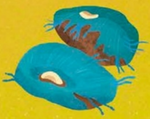
A

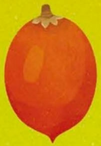
tv

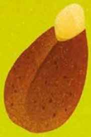
Seeds for animals

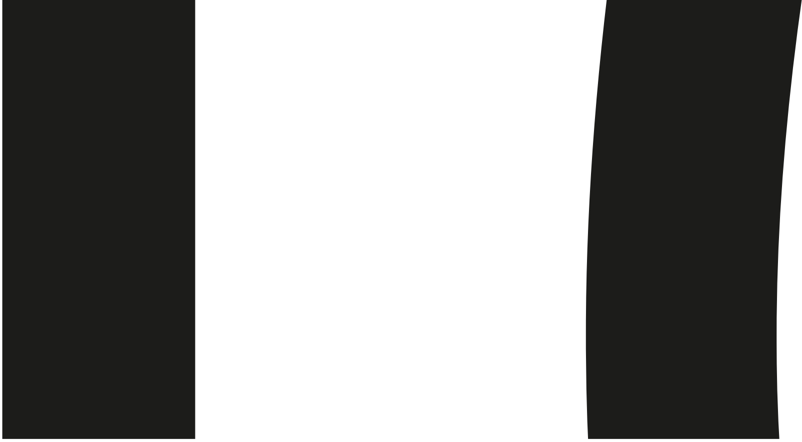
Some plants rely on animals to spread their seeds in droppings after their fruits are eaten. Blackberry seeds are spread by birds, traveler's palm seeds by lemurs, and tucuma palm seeds by river fish. The seeds of violets attract ants that carry them away.











M

d

th

in

h

C

T

W

h

o

B

fr

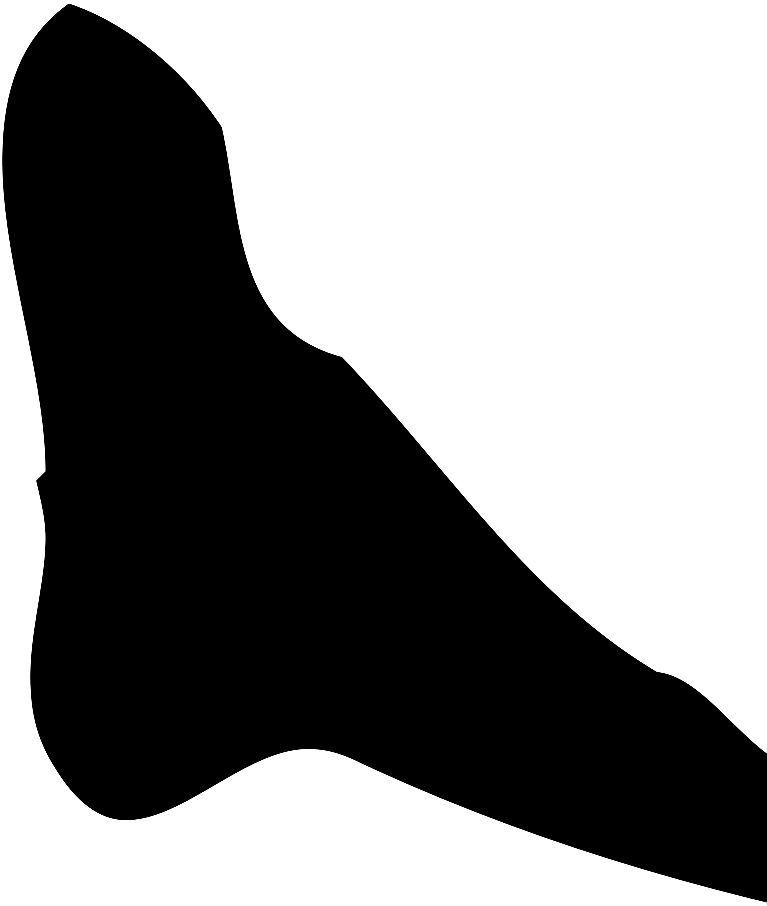
T

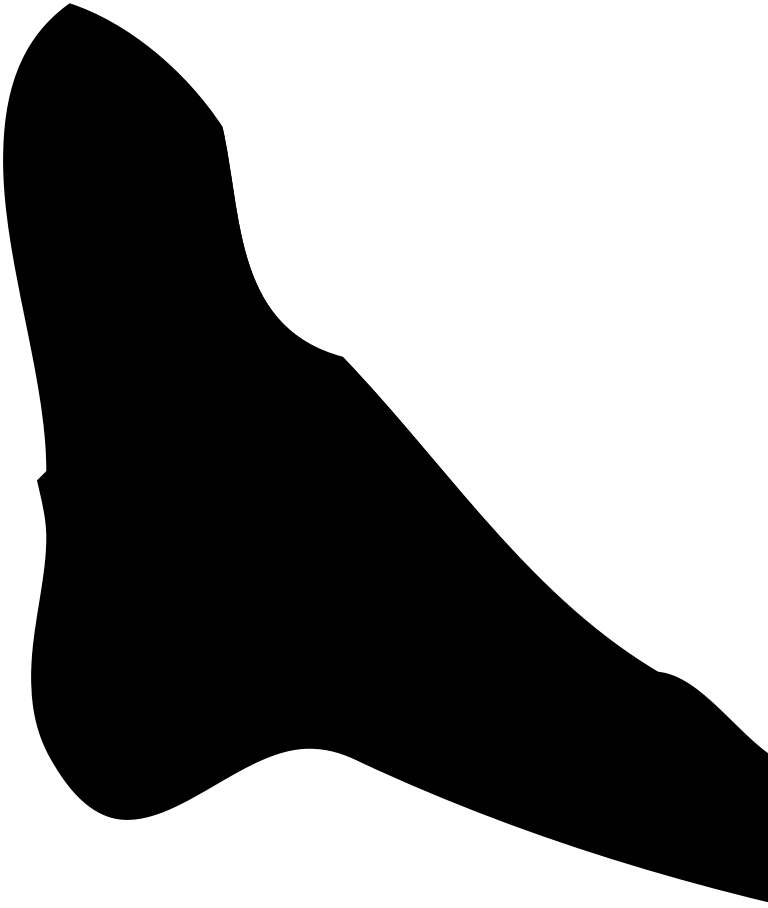
se

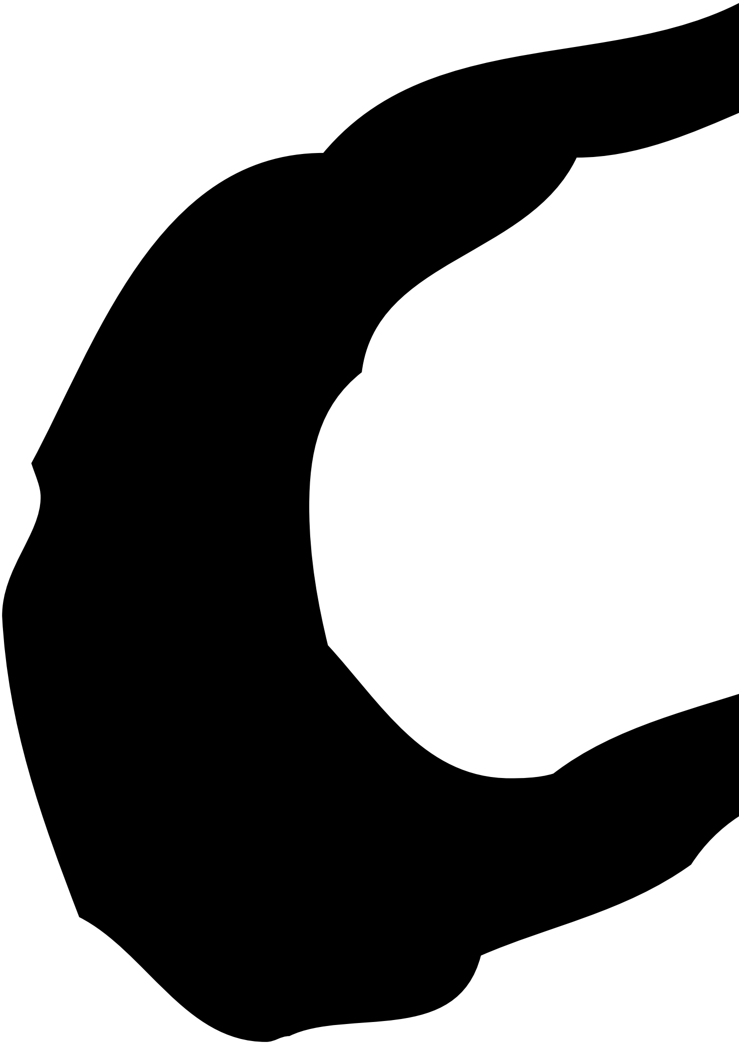
V

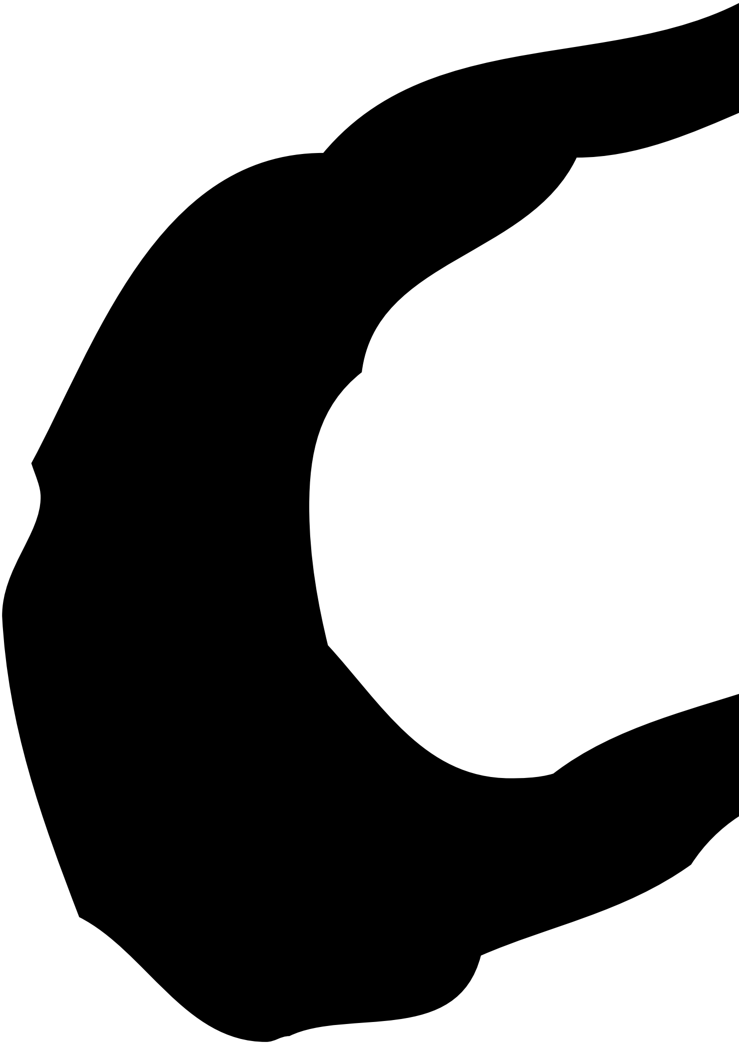
T

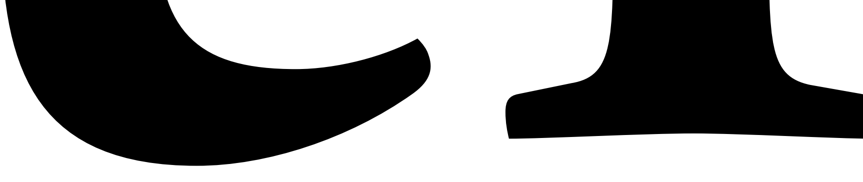
fr











A-

e

a

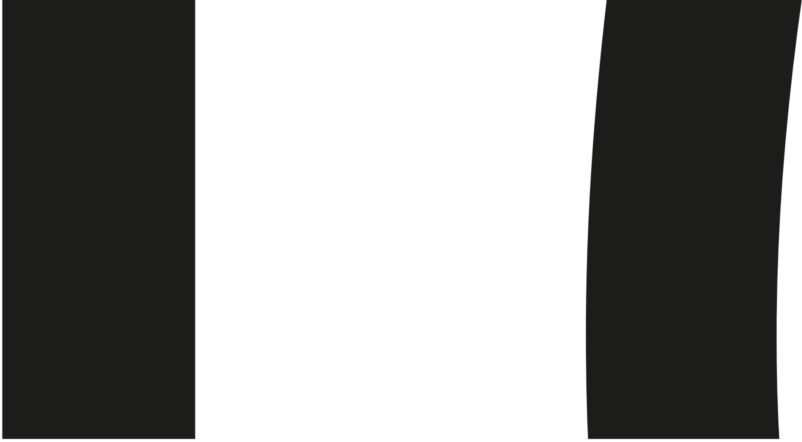
P

O

a

ye

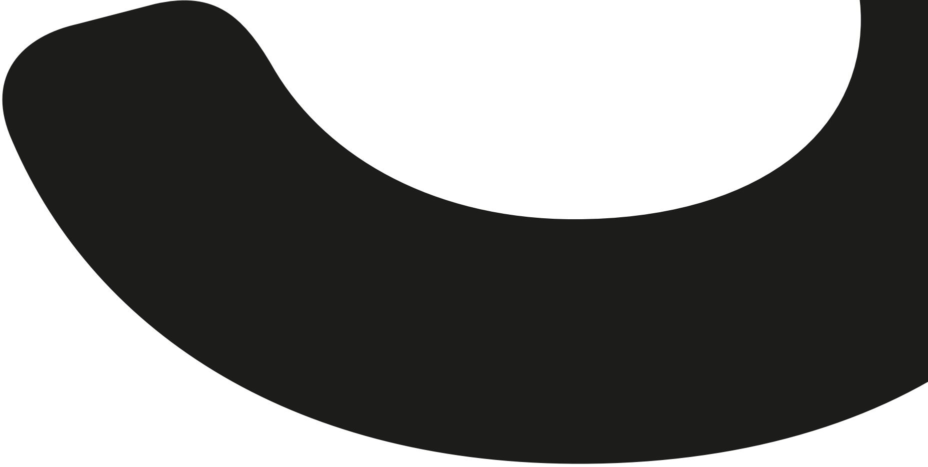
Spreading seeds



[redacted]

[redacted]

L



S

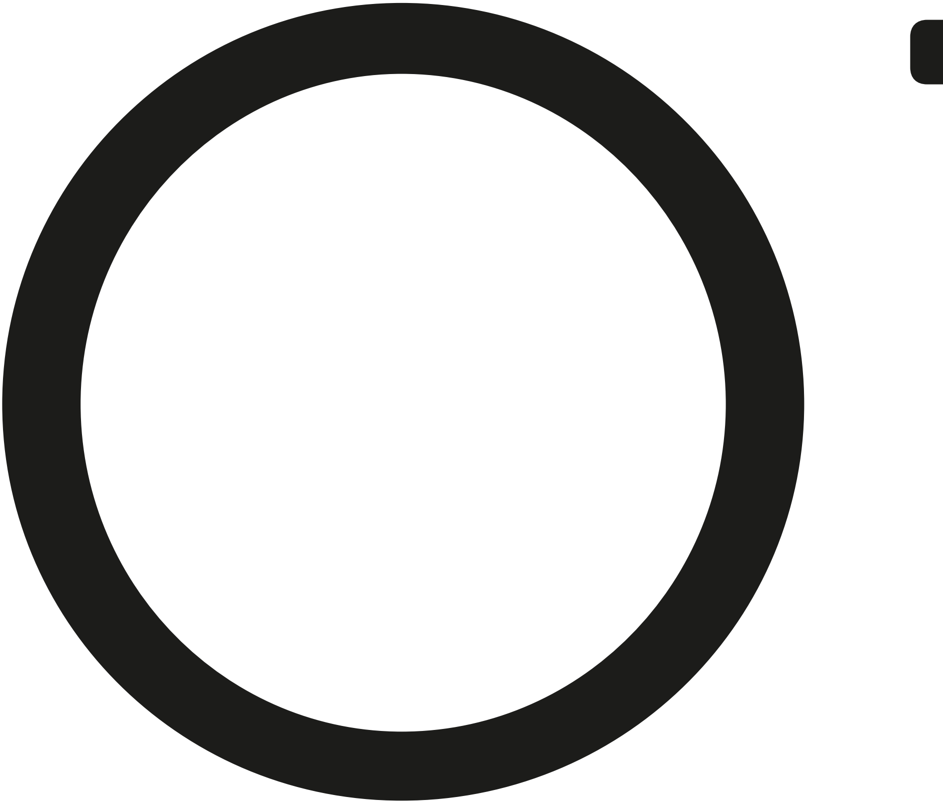
a

S

a

u

A



W

th

SU

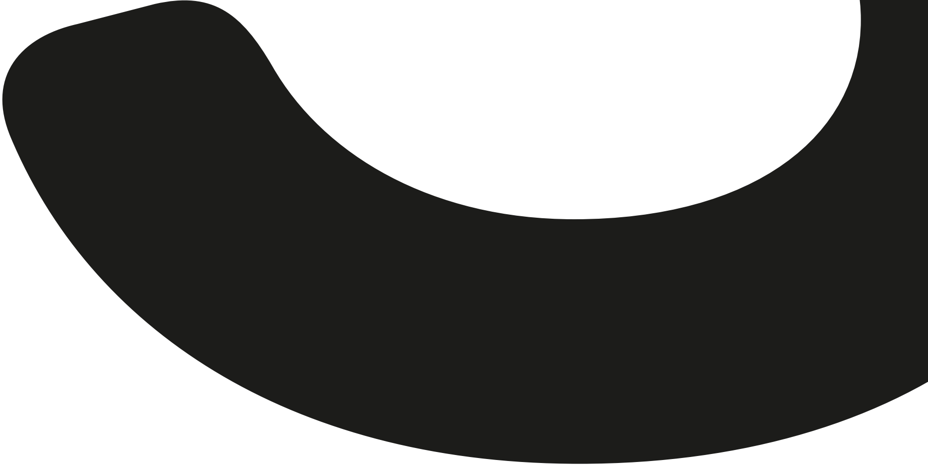
T

b

t

C

a



T

fr

sp

b

fe

T

fr

W

th

SE

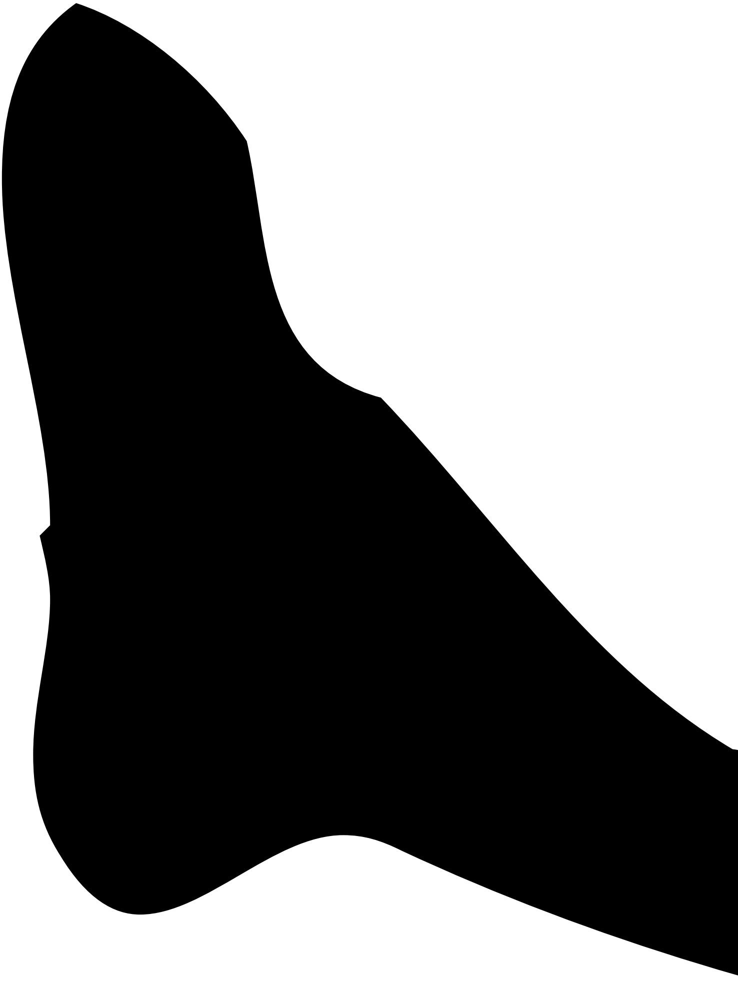
T

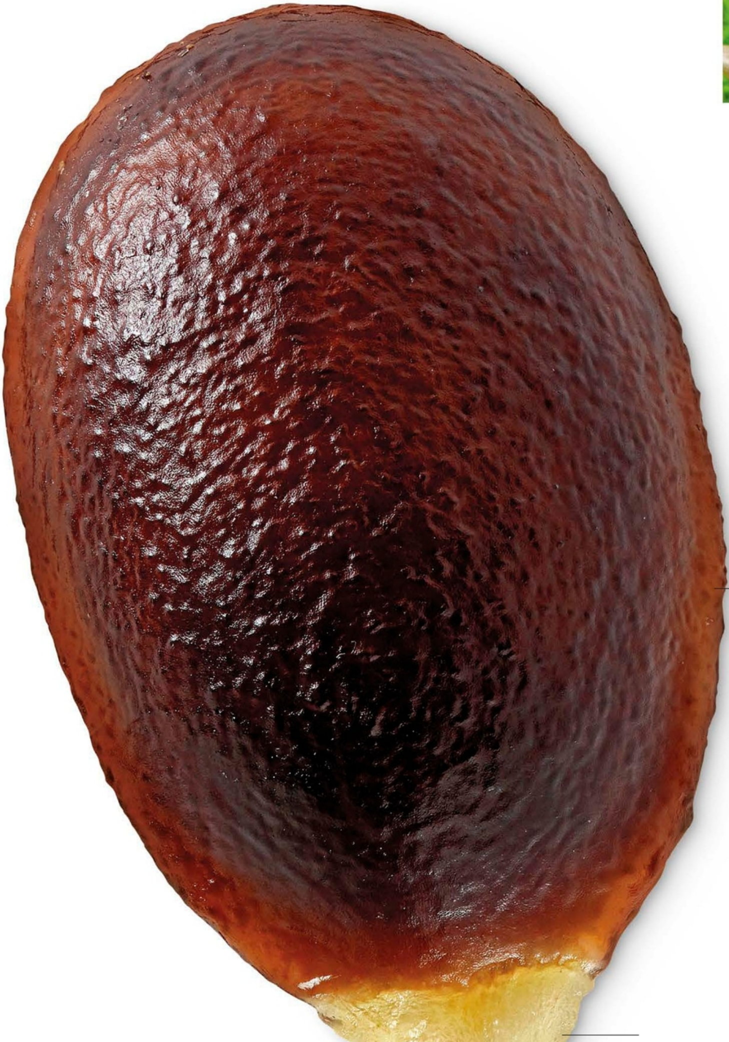
b

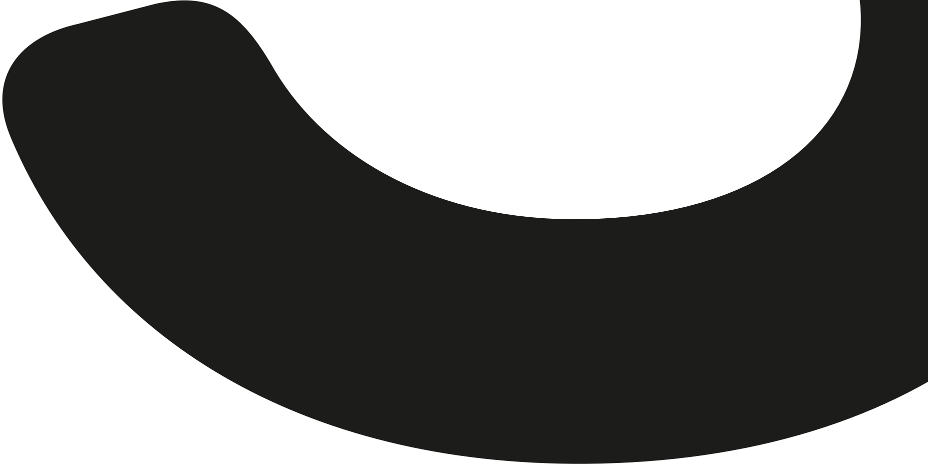
C

T

h







T

S

A

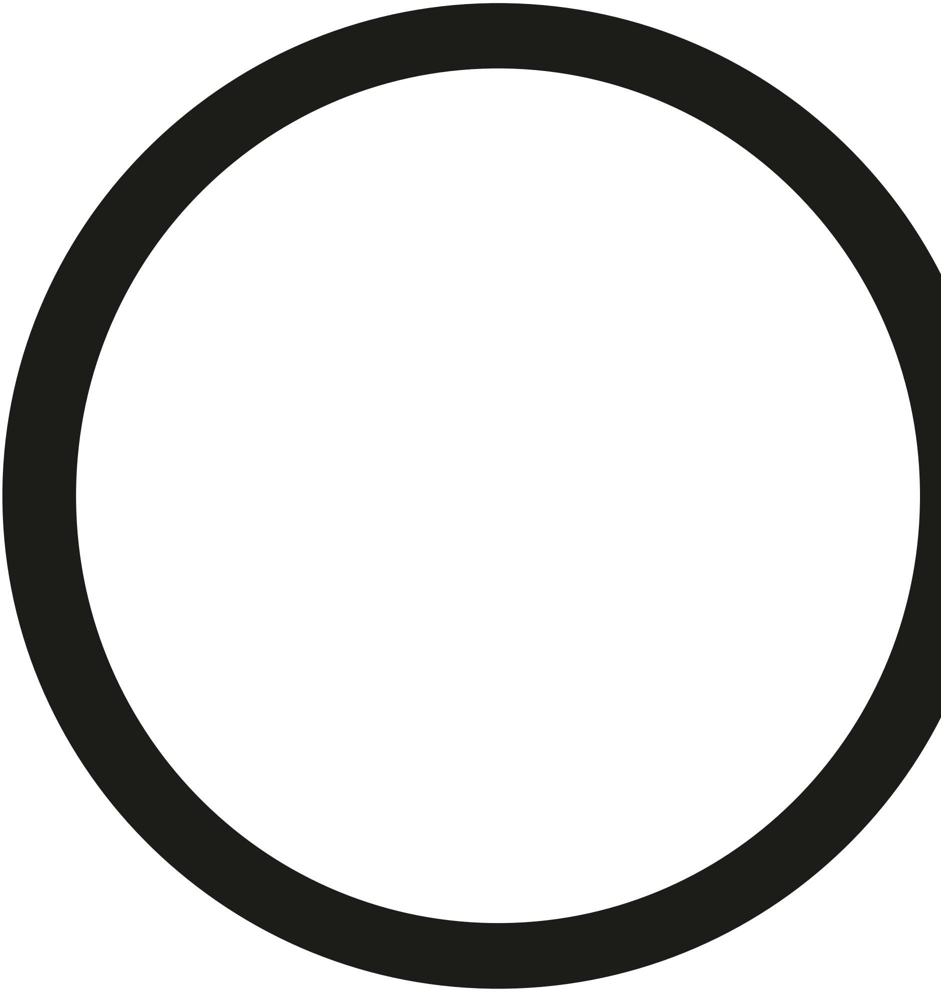
Vi

E

in

CU

h



th

O

fr

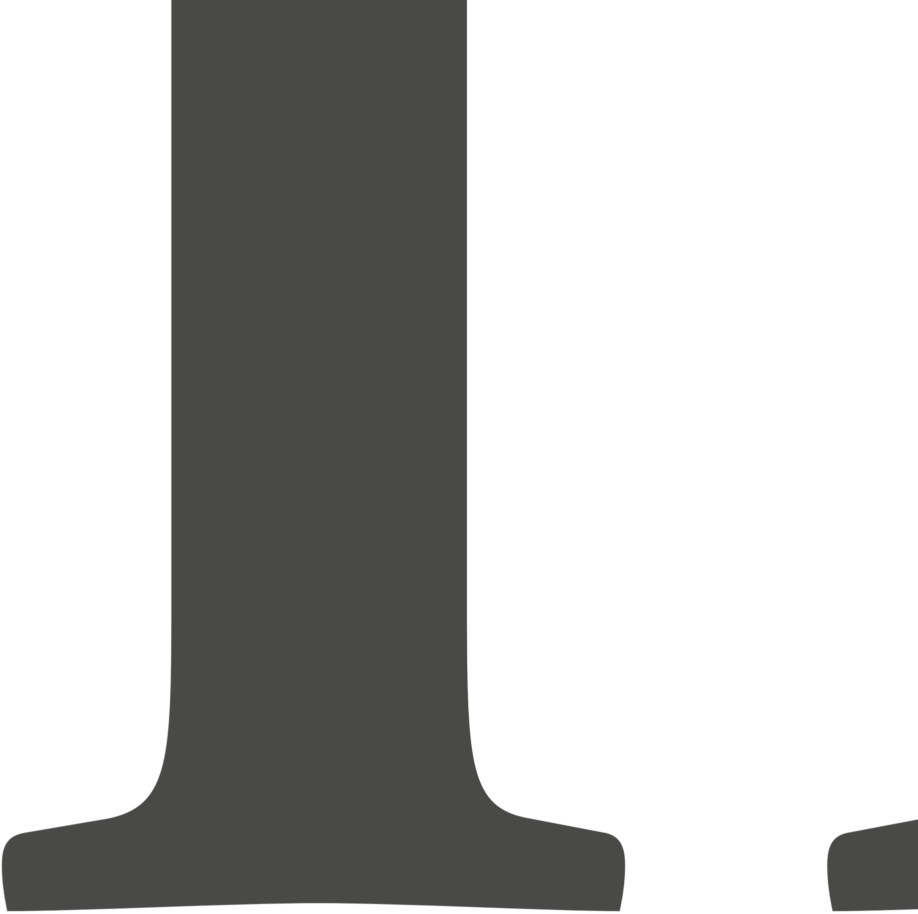
D

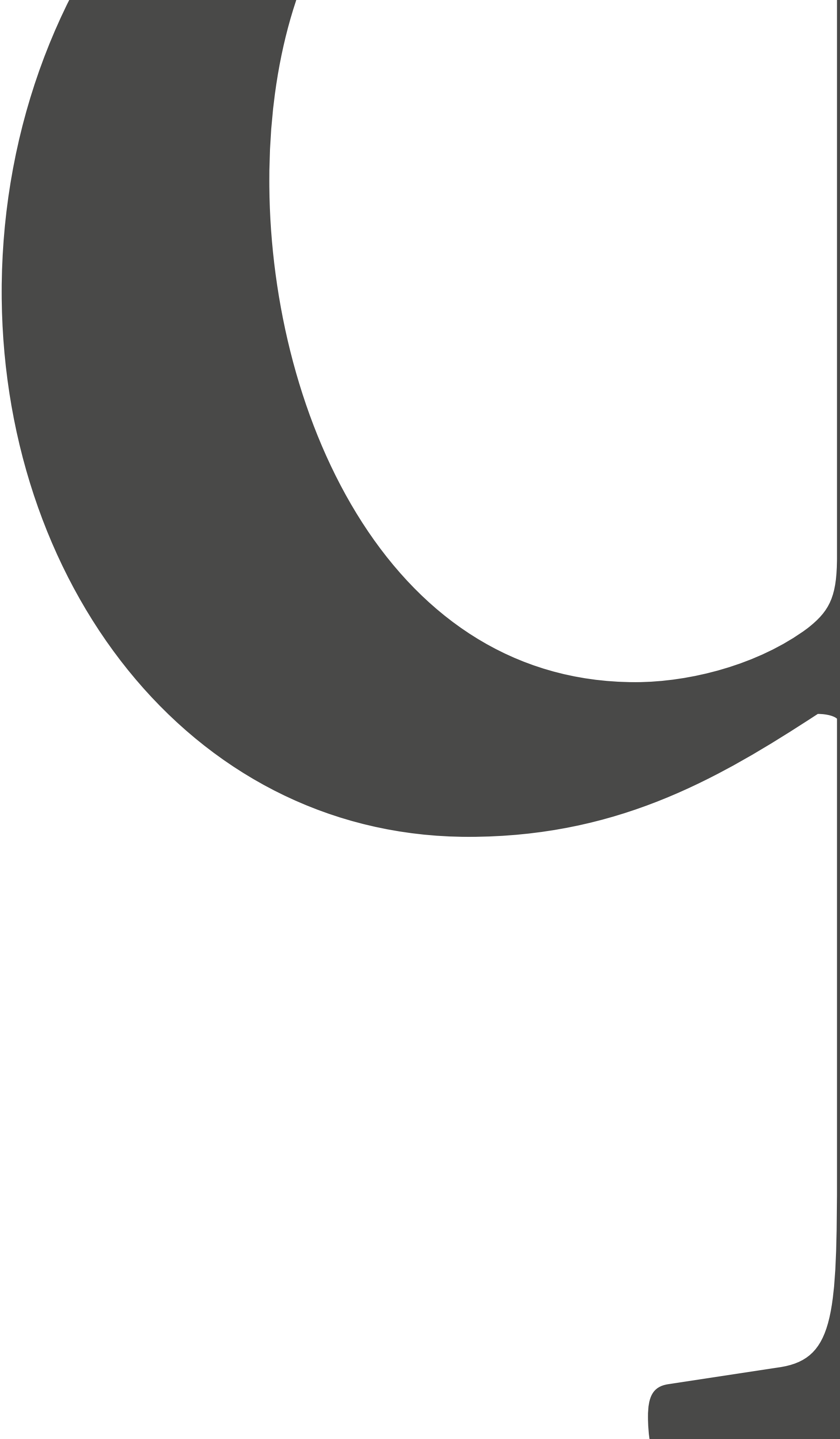
th

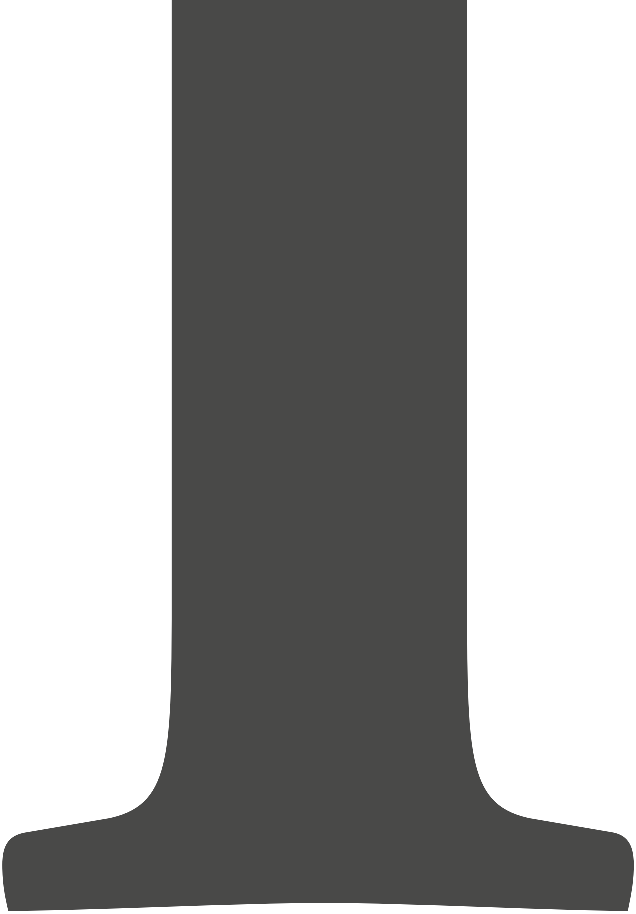
d

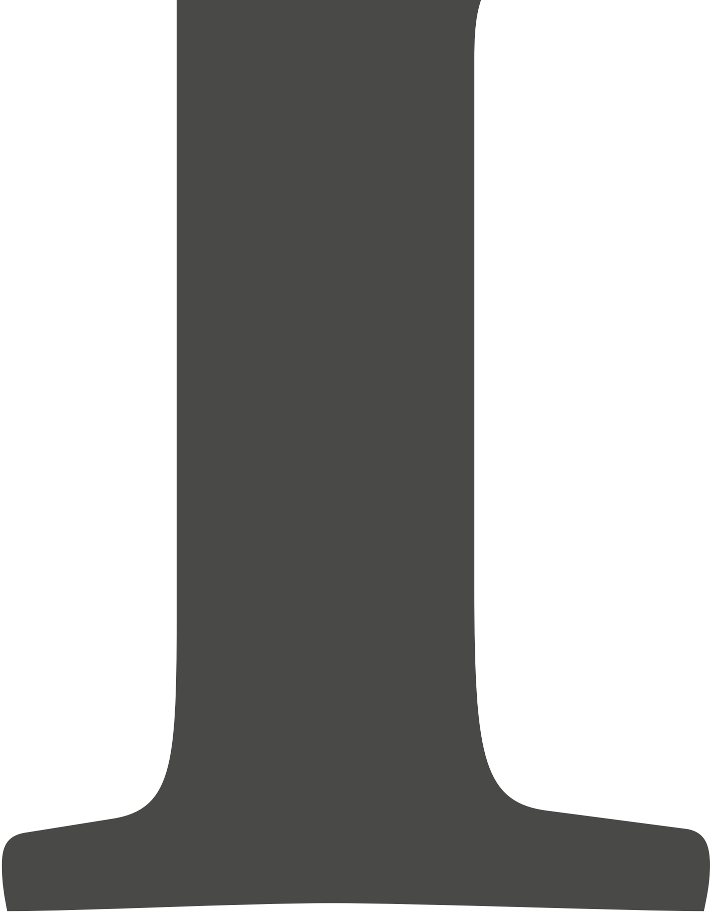
C

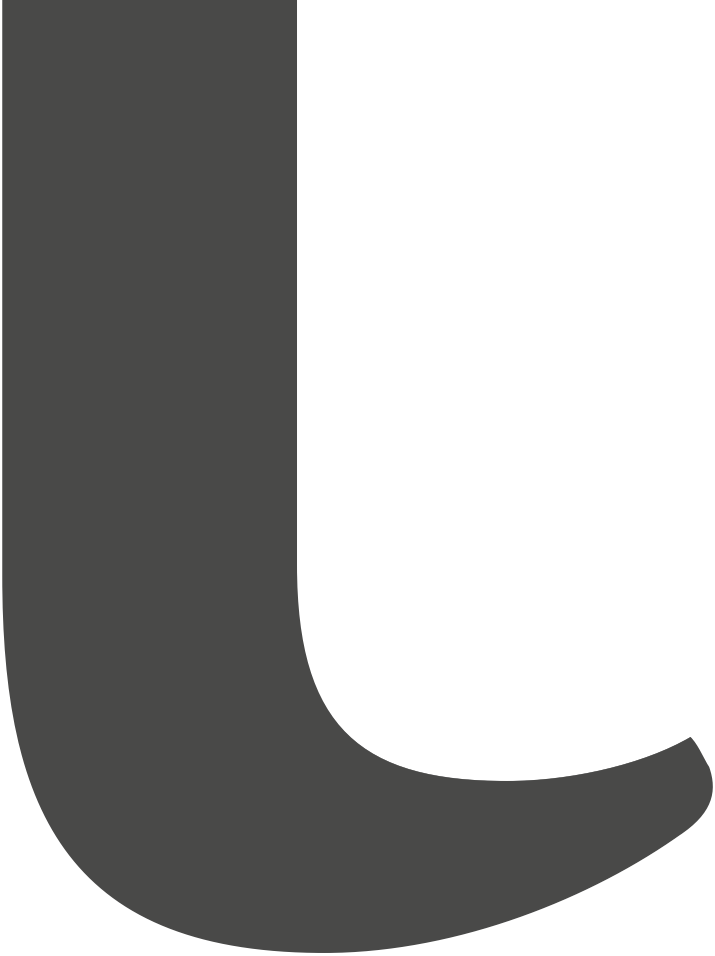
it

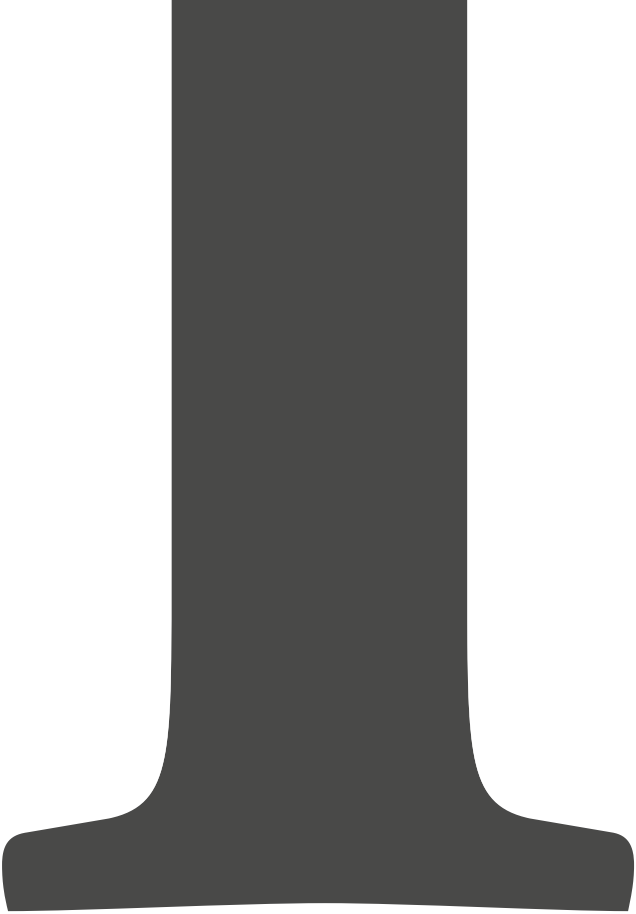


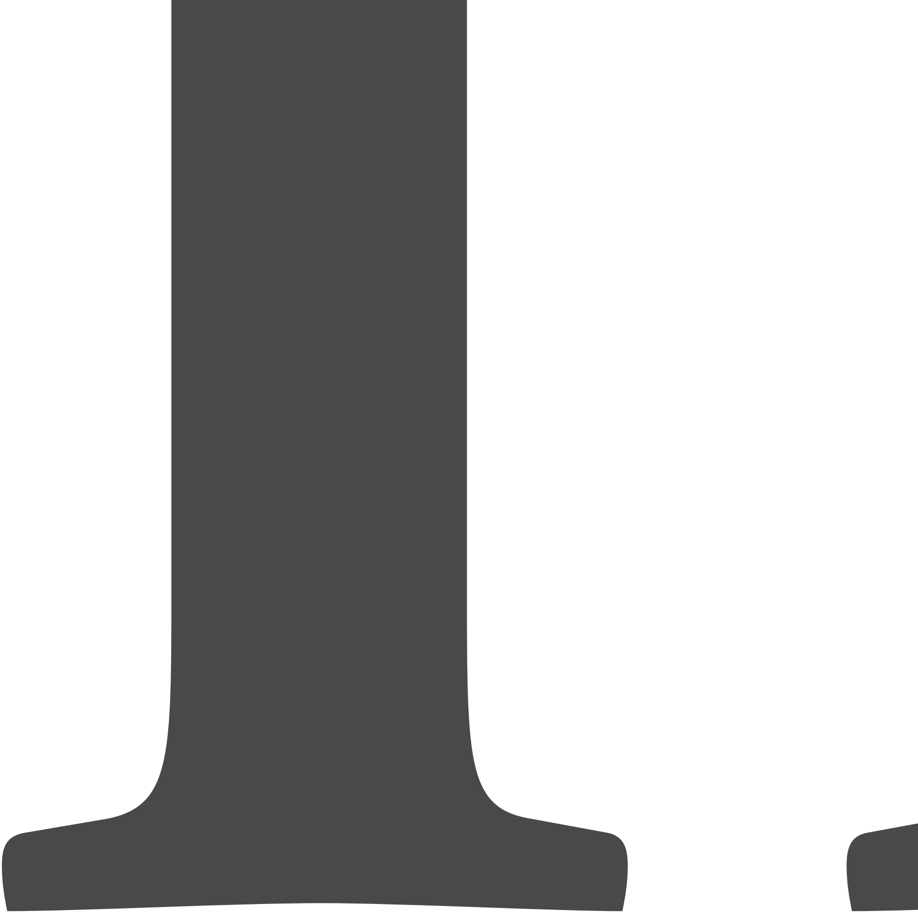


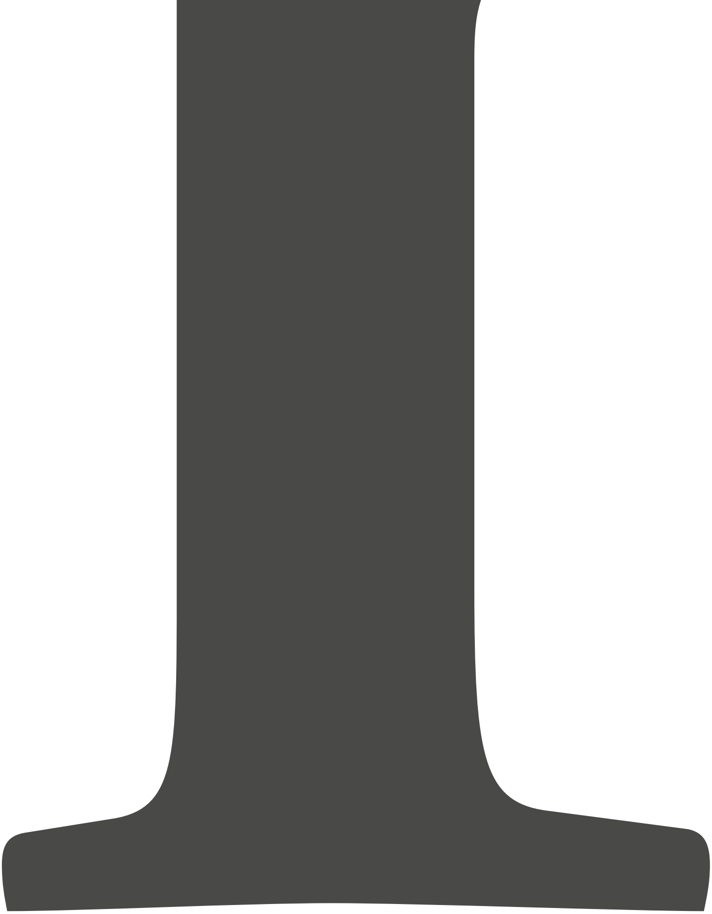


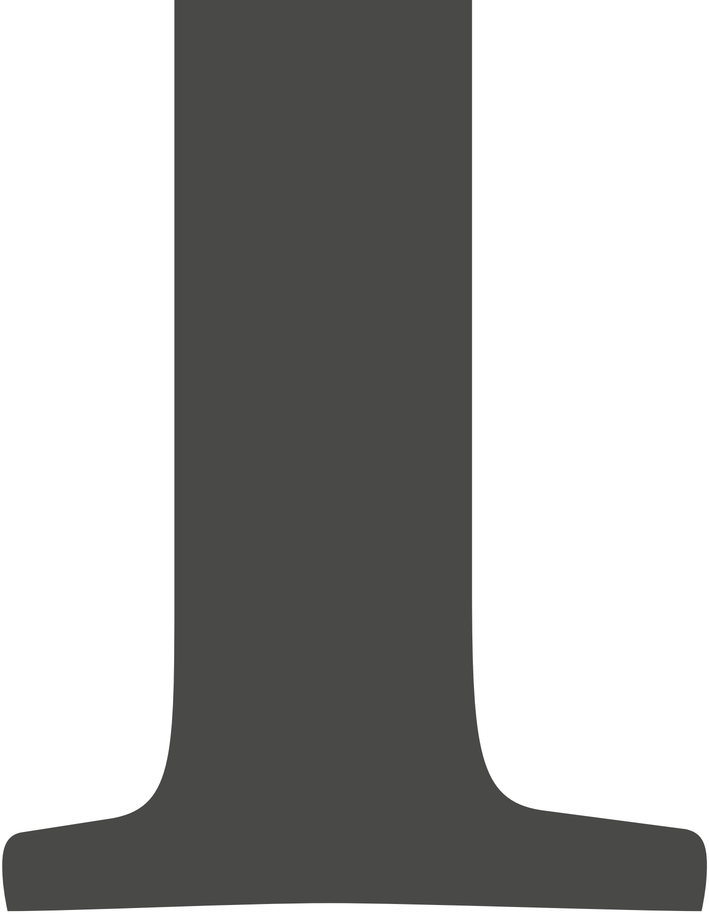


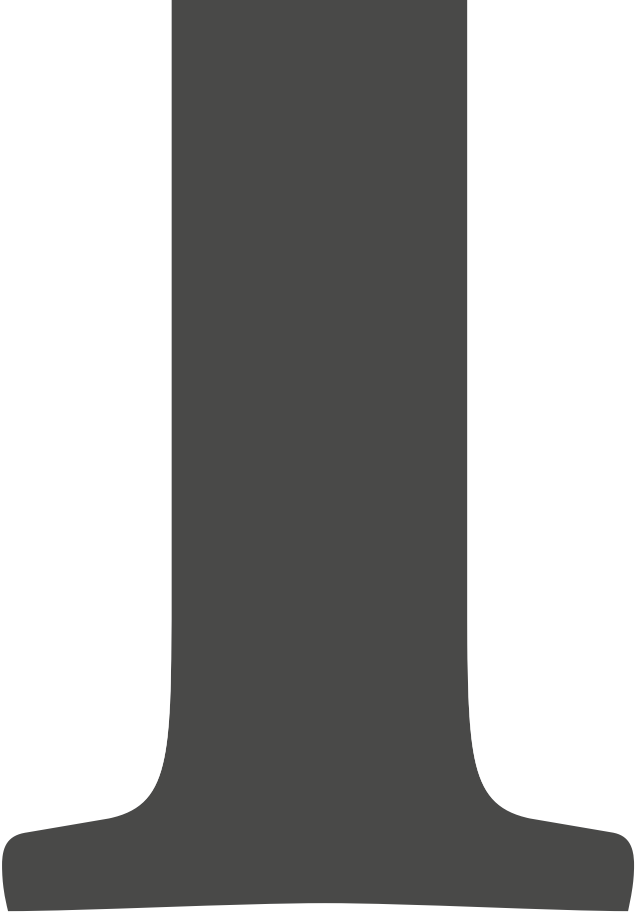


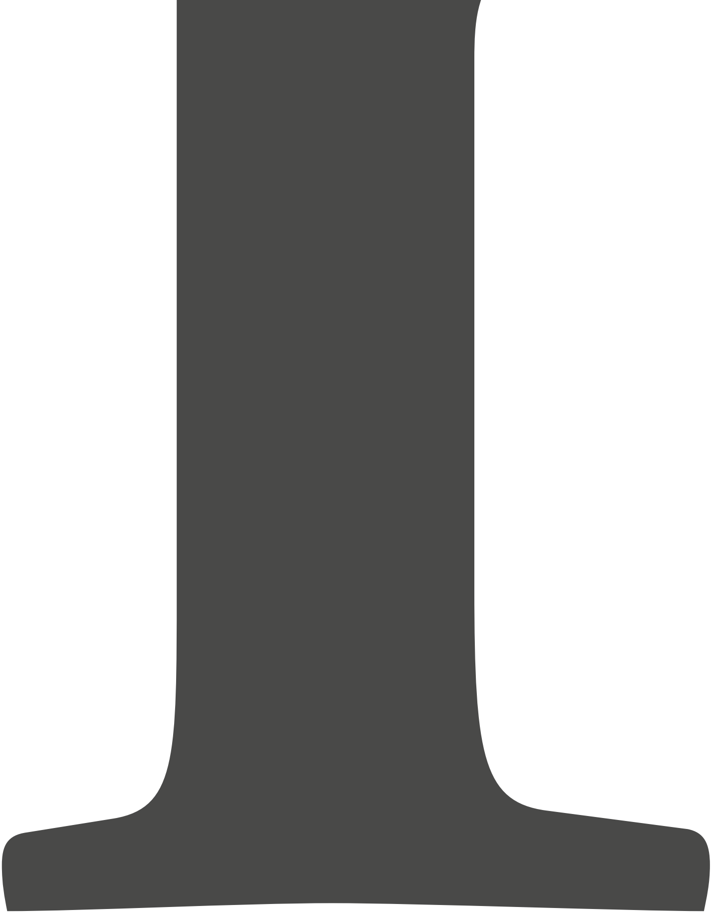


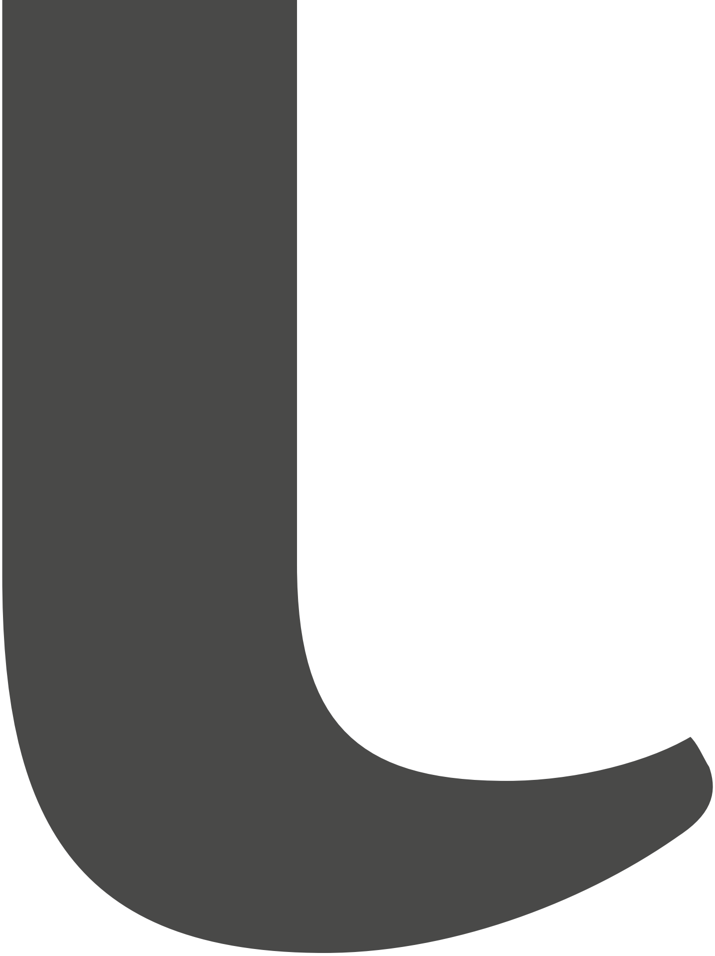




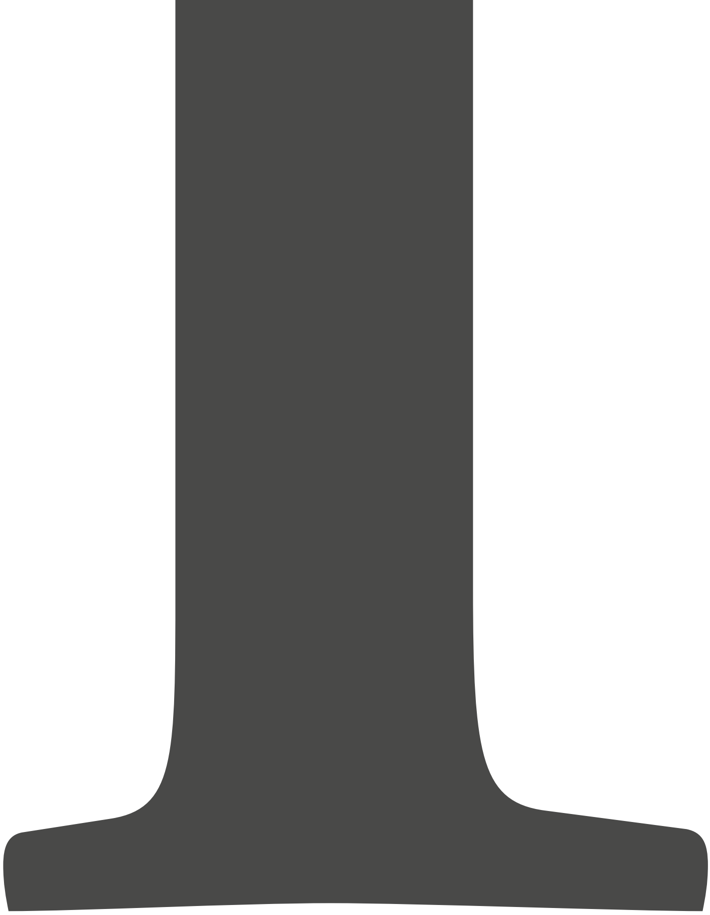


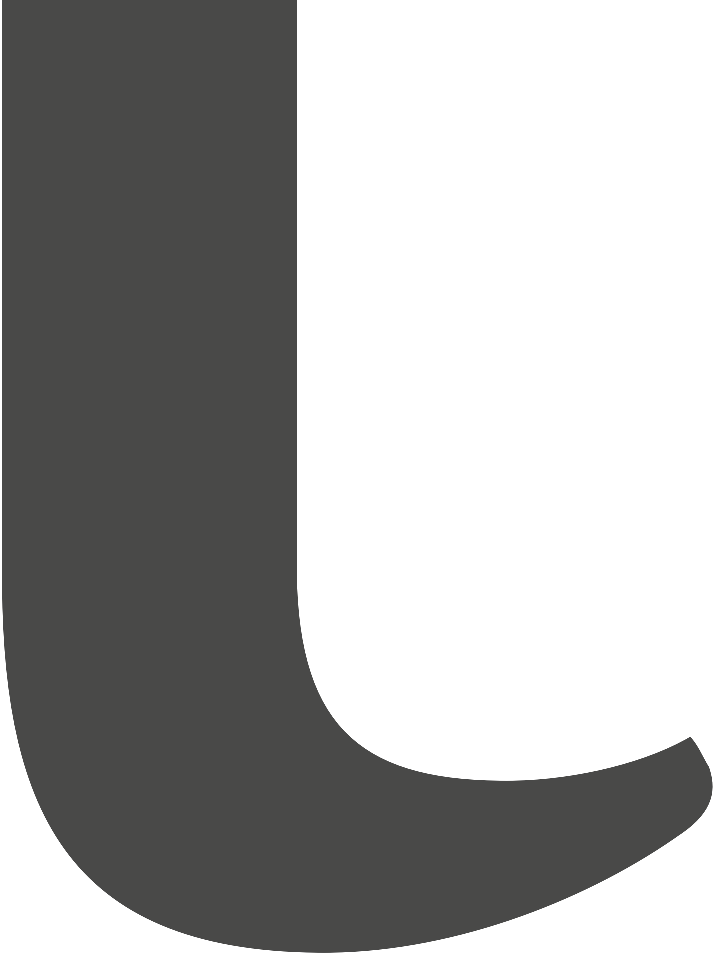


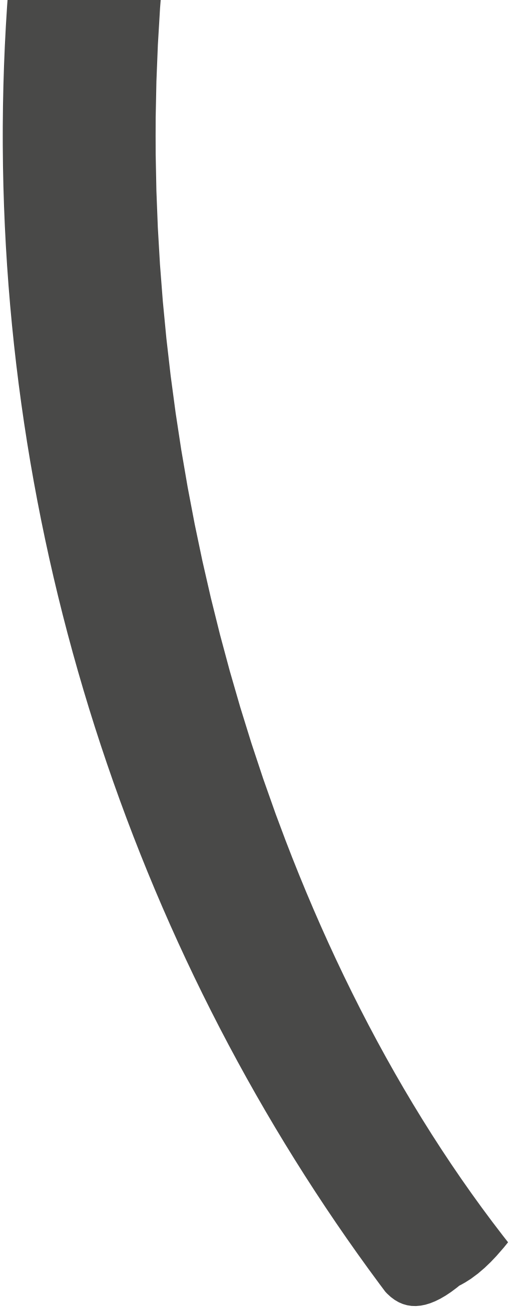


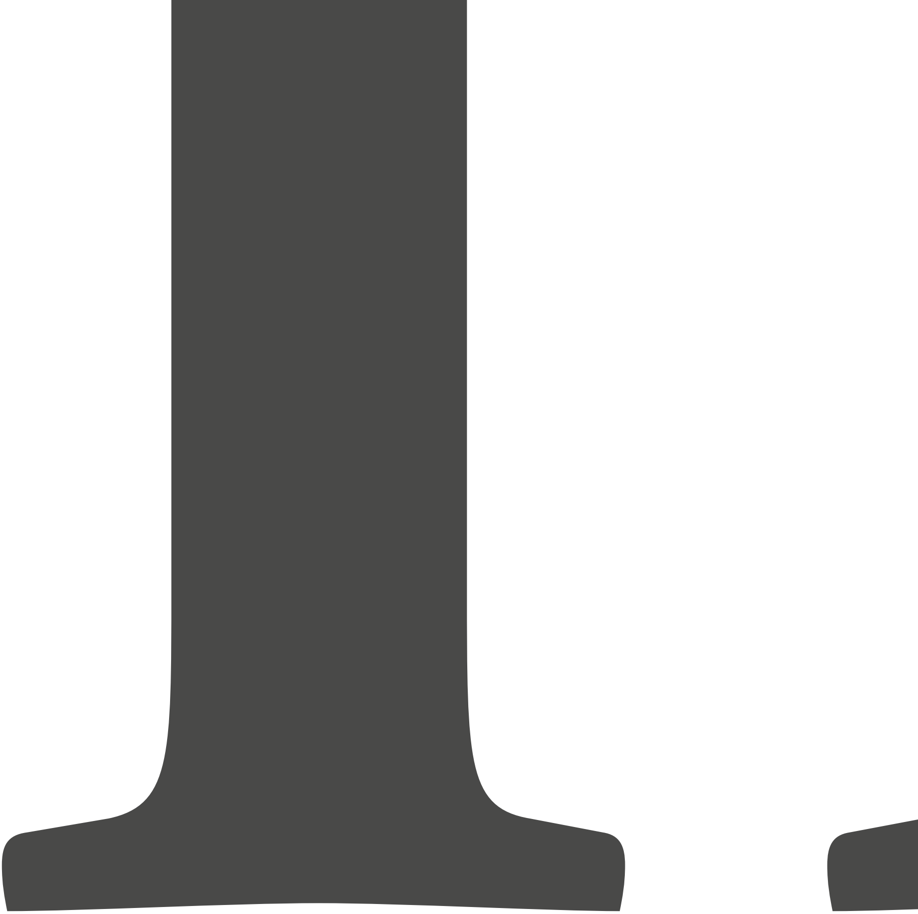


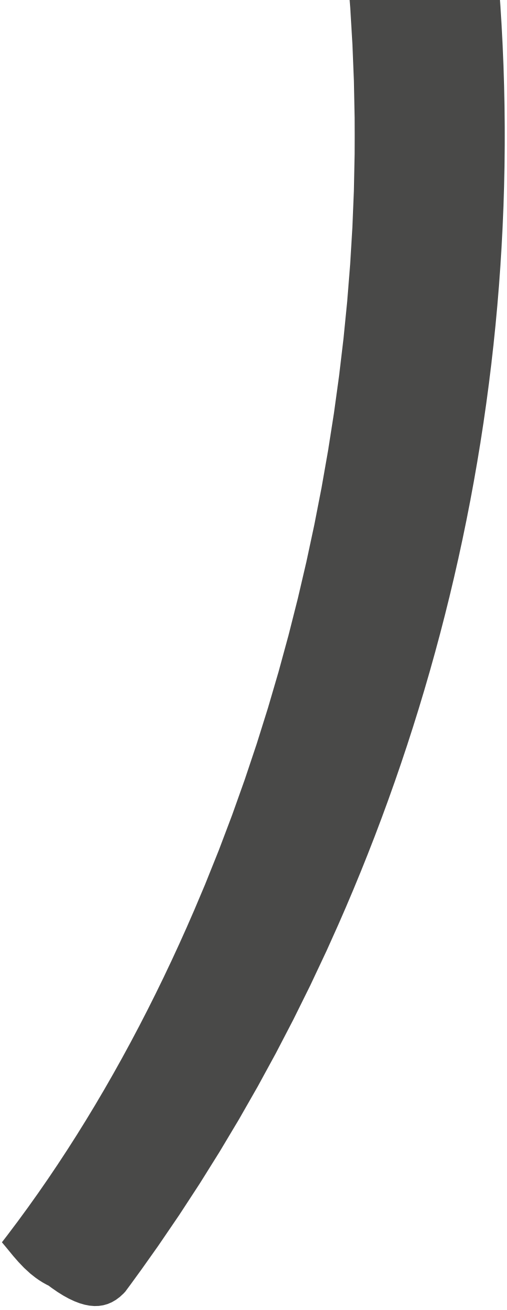
2





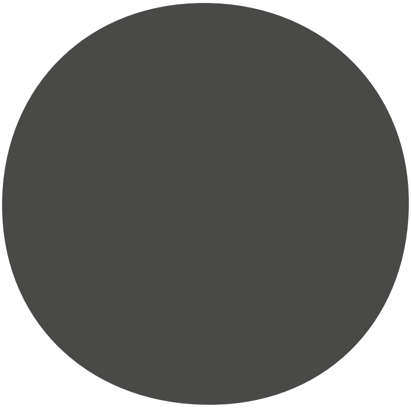




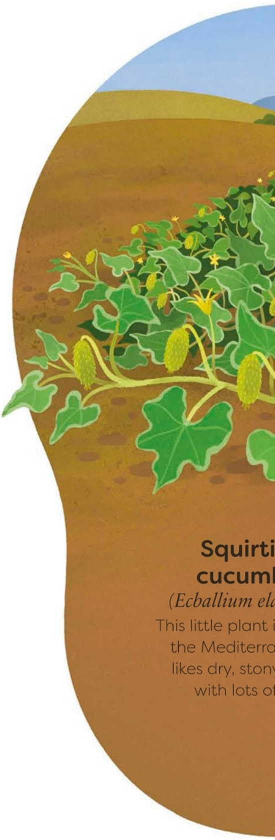


V

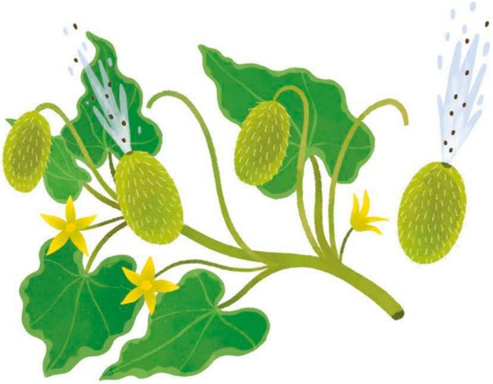
y



Squirting cucumber



Squirti
cucumb
(Ecballium ela
This little plant i
the Mediterra
likes dry, stony
with lots of



Explosive seeds

The squirting cucumber has yellow flowers, and once bees have pollinated the female blooms, they develop into long, round fruits. The fruits swell with slimy juice until they are ready to burst, then pop off their stems. The force of the slime spraying in one direction powers the fruits the other way.

10

Q

U

[redacted]

[redacted]

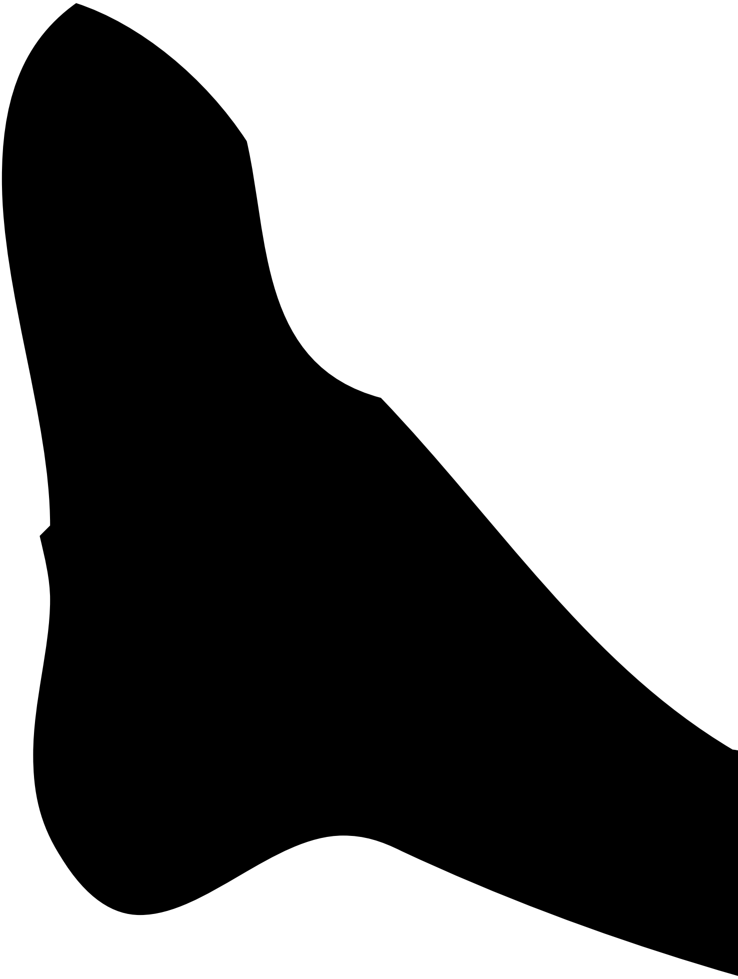
[redacted]

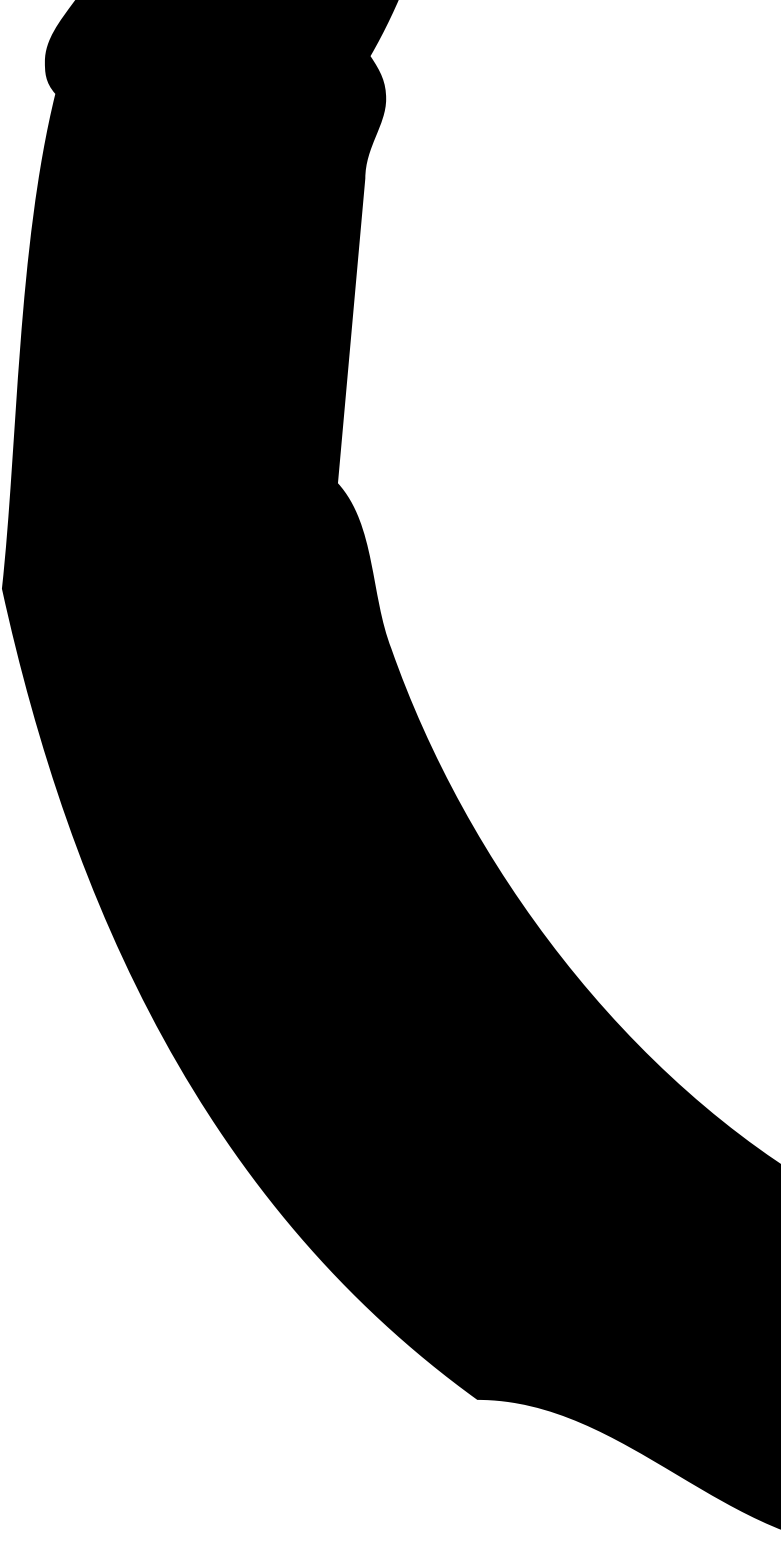
G

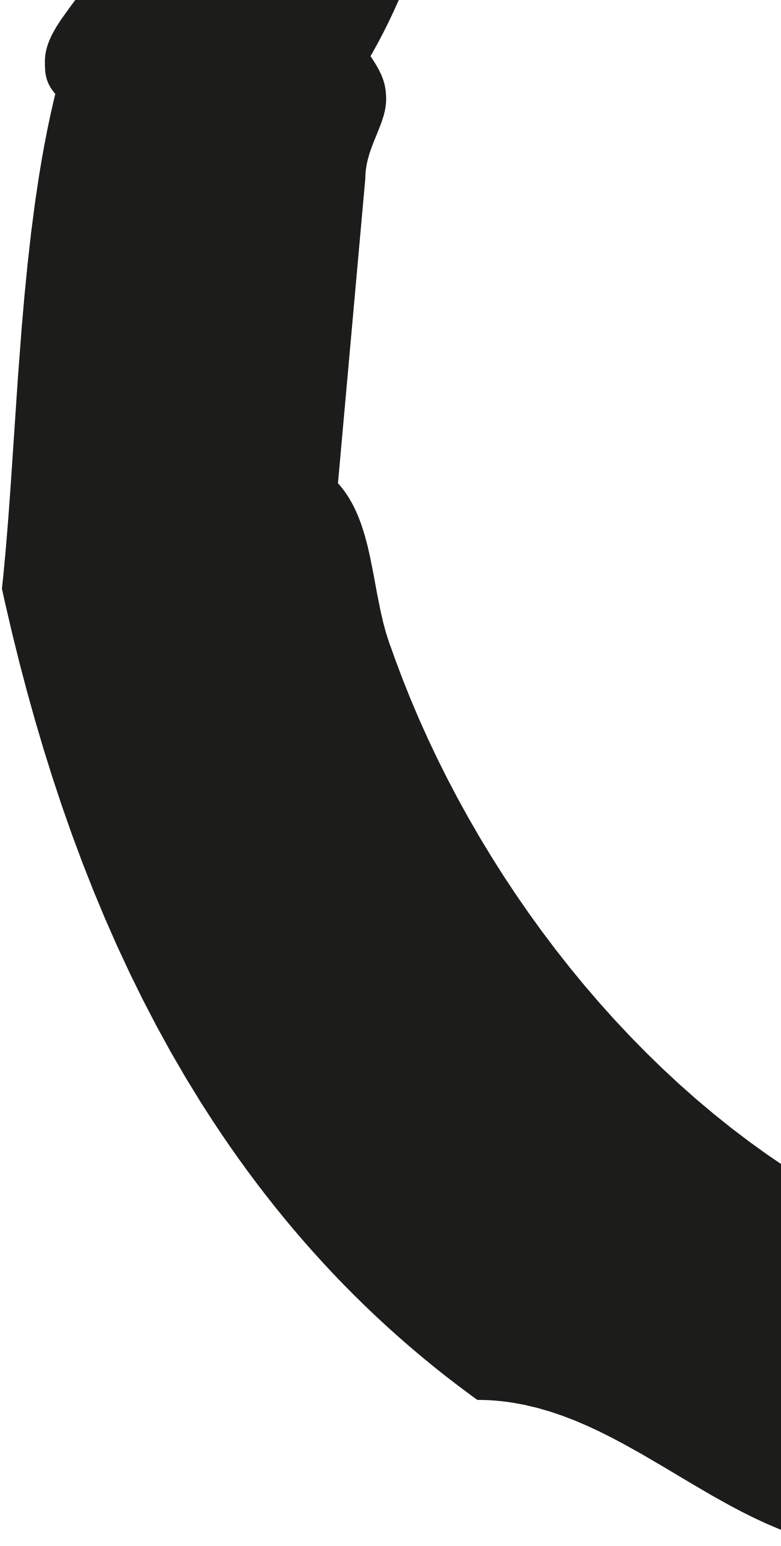
U

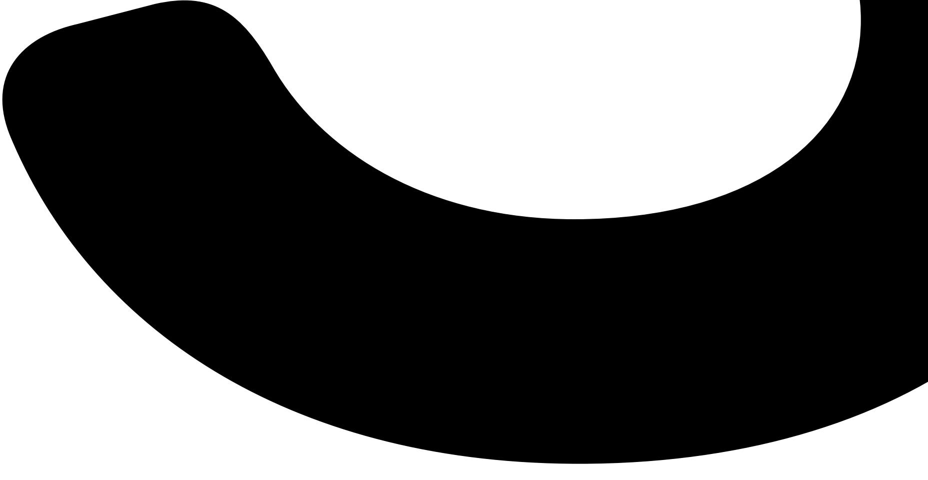
U

IV









T

th

lik

W

T

fl

th

I

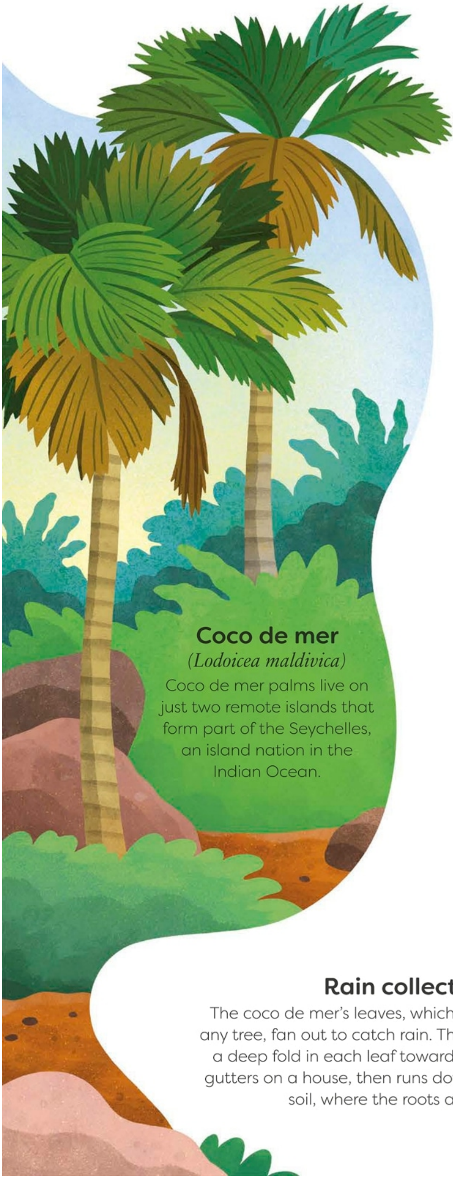
Sl

th

th

p

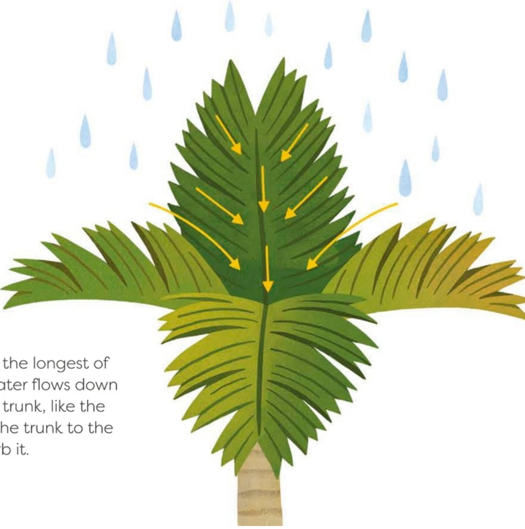
Coco de mer



Coco de mer

(Lodoicea maldivica)

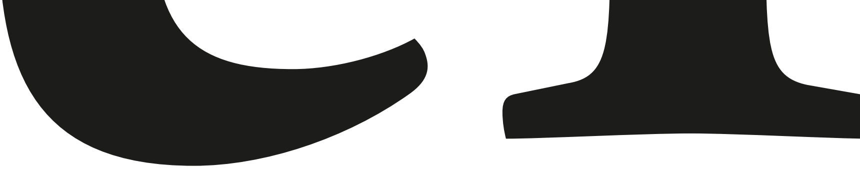
Coco de mer palms live on just two remote islands that form part of the Seychelles, an island nation in the Indian Ocean.

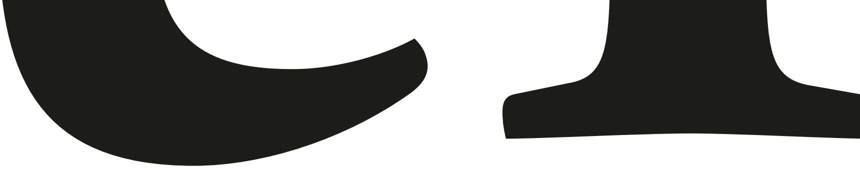


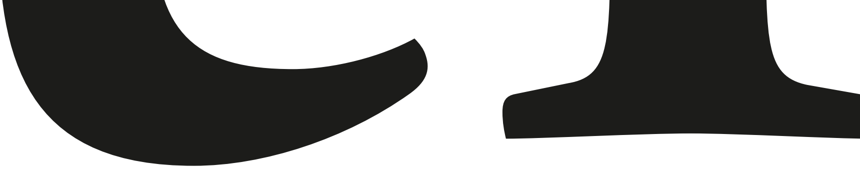
Rain collector

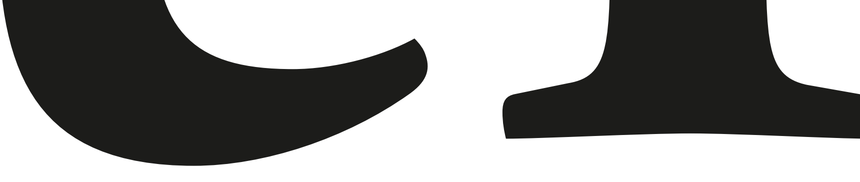
The coco de mer's leaves, which are the longest of any tree, fan out to catch rain. The water flows down a deep fold in each leaf toward the trunk, like the gutters on a house, then runs down the trunk to the soil, where the roots absorb it.

10









T

a

a

g

S

C

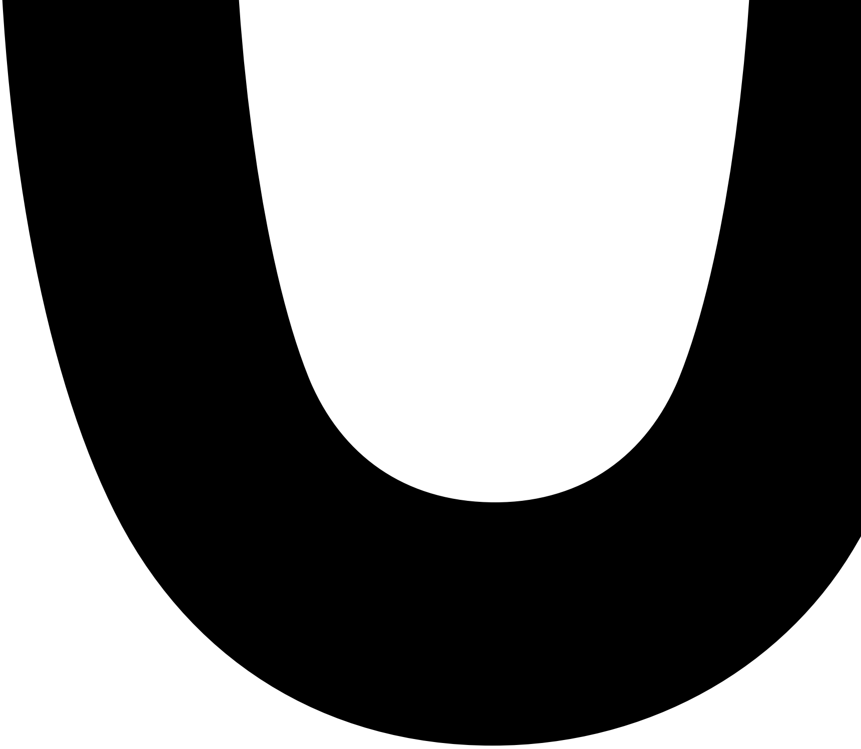
ju

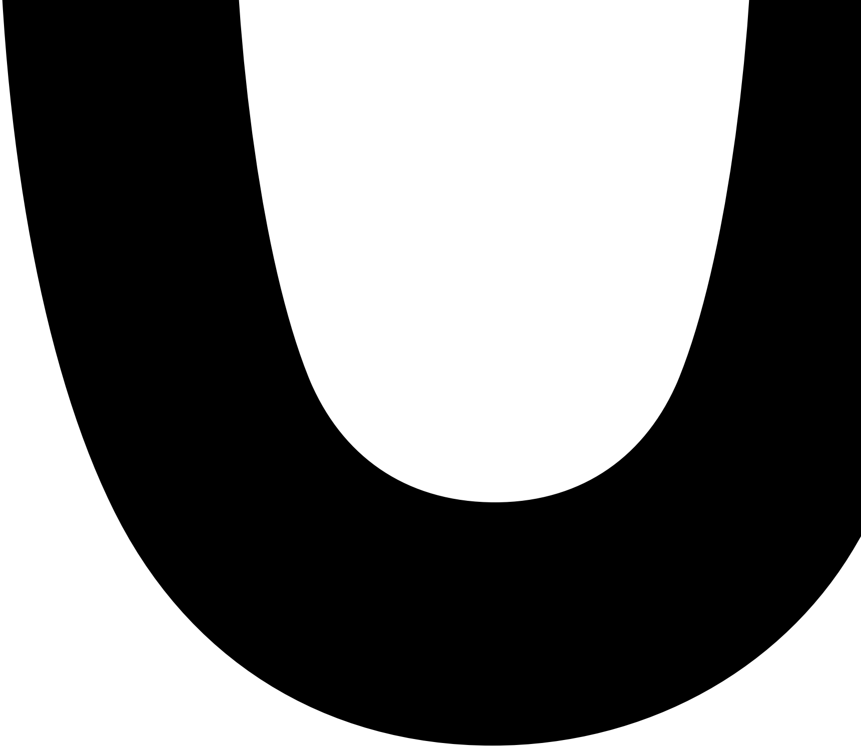
f

a

l

COCO





IV

A

C

(2

m

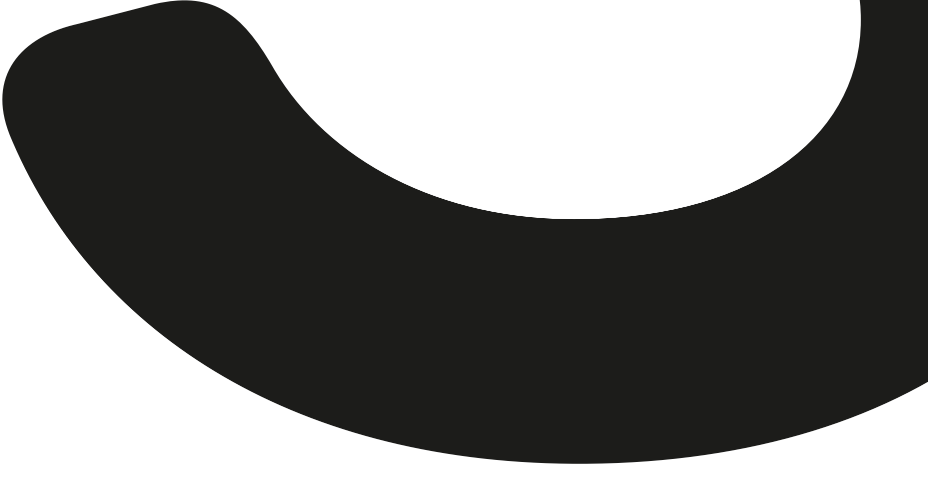
C

m

T

iS

Ve



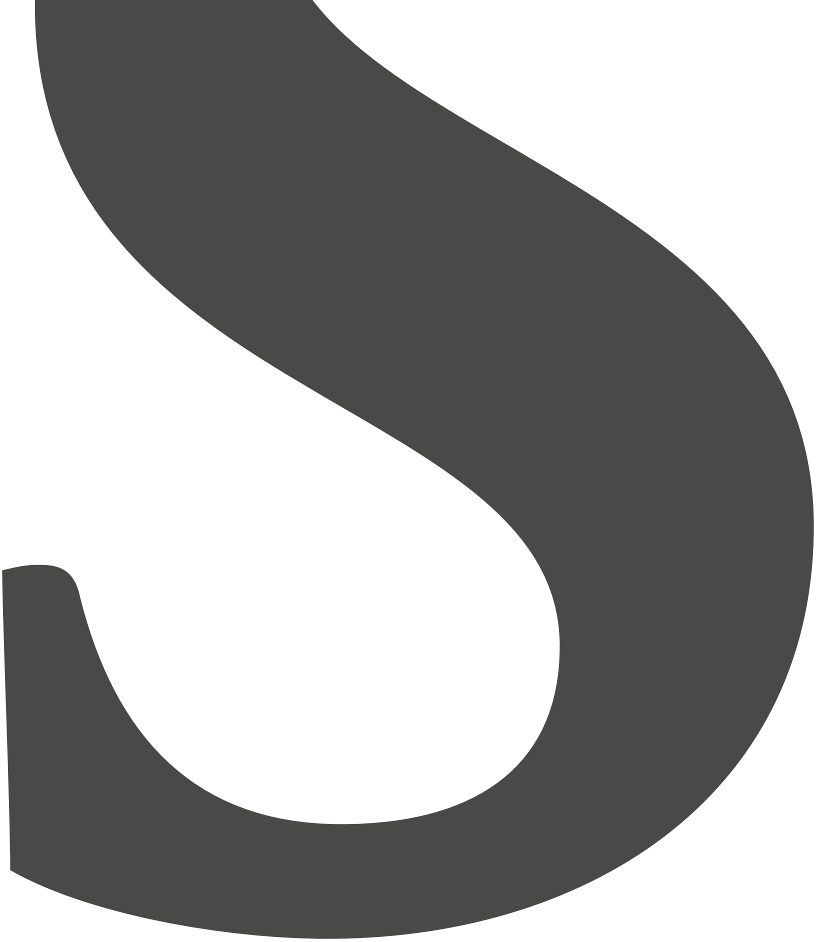
T

m

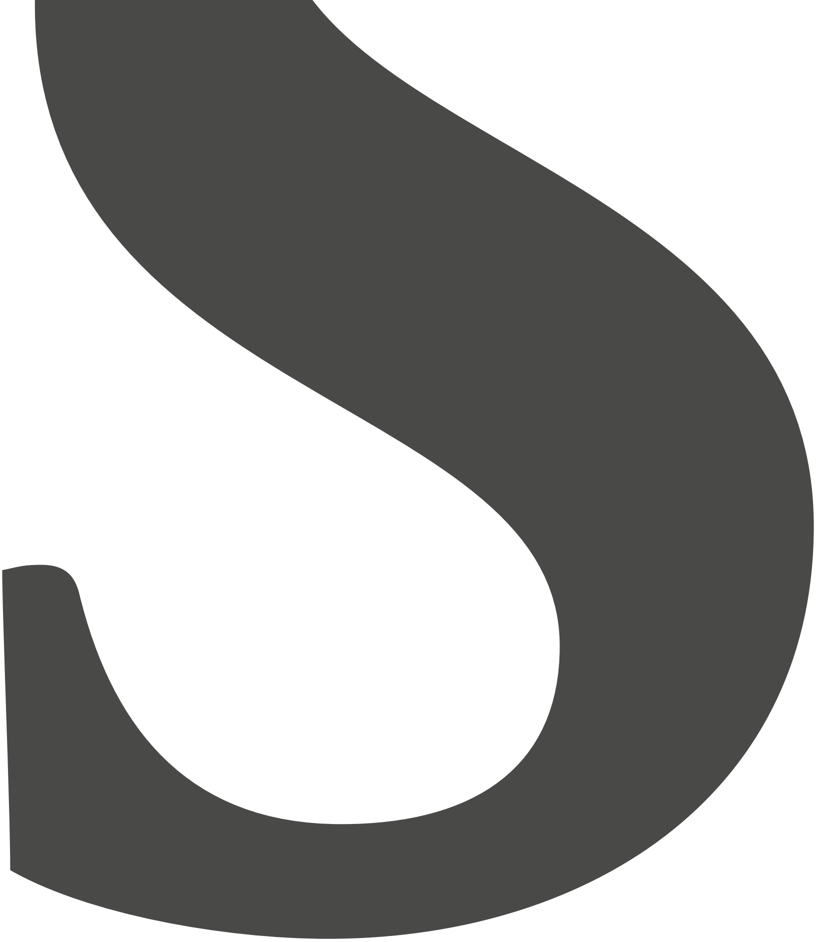
a

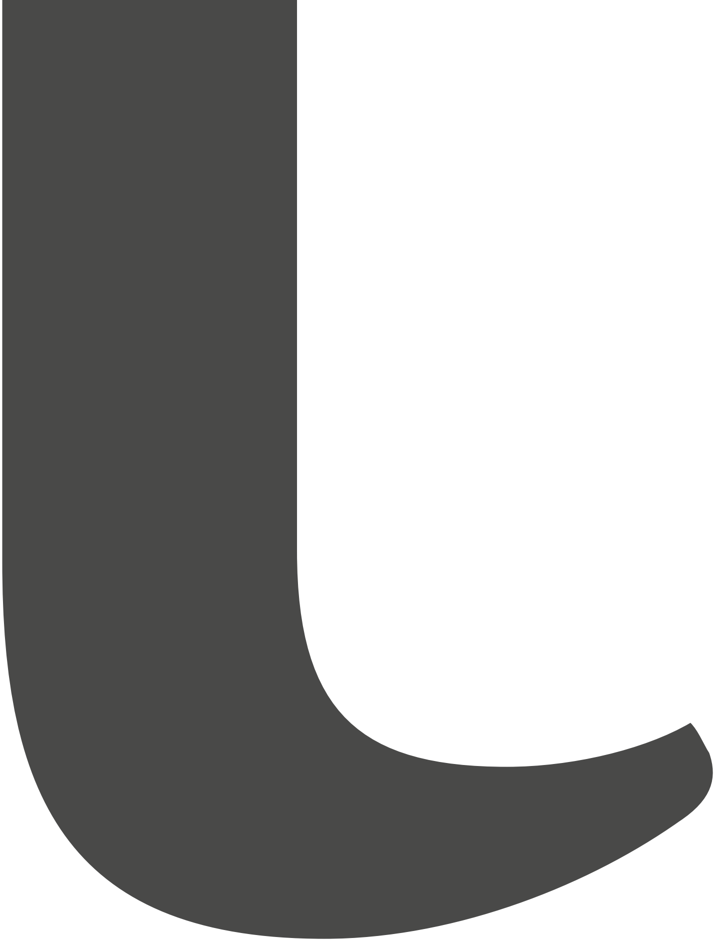
C

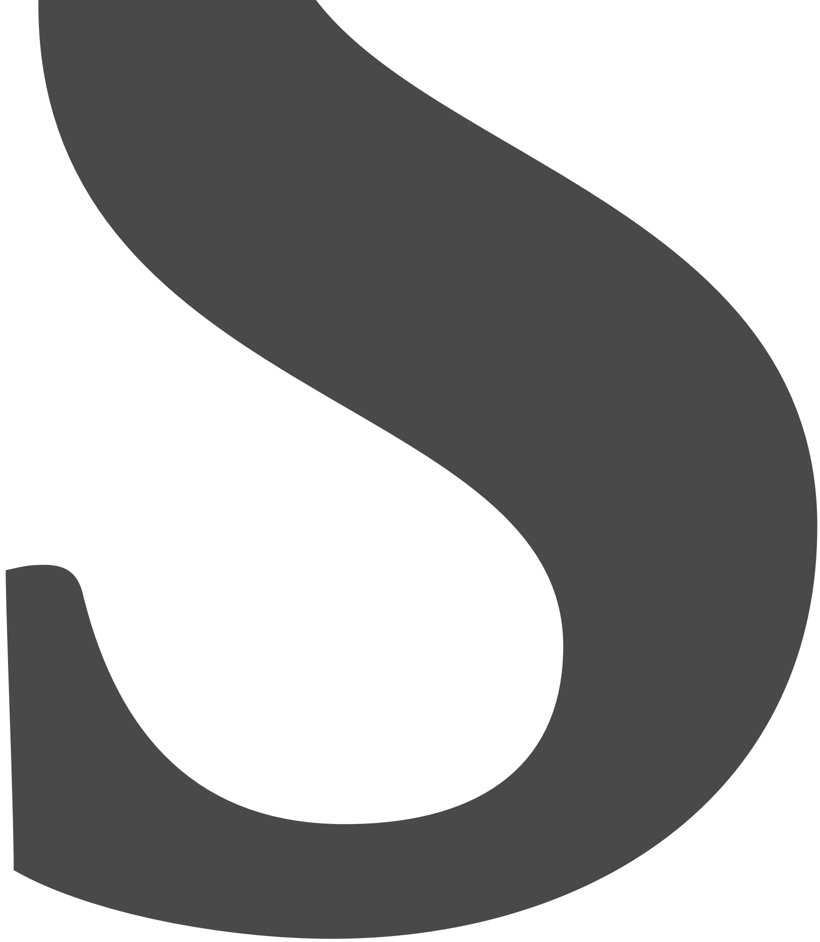
m



V





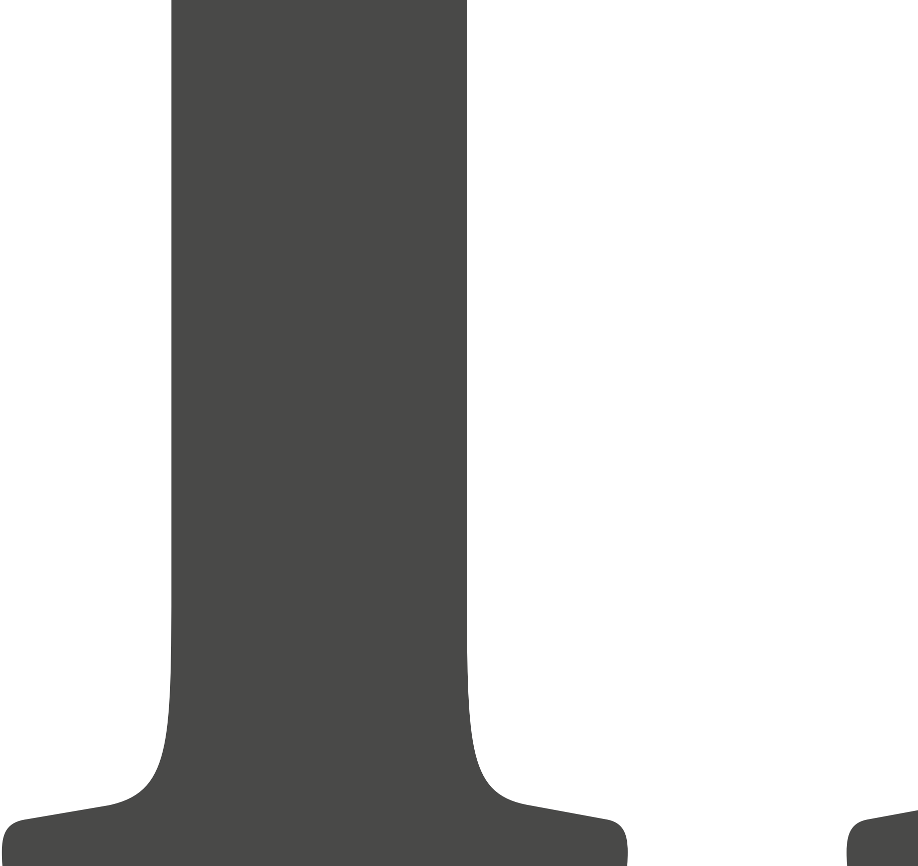


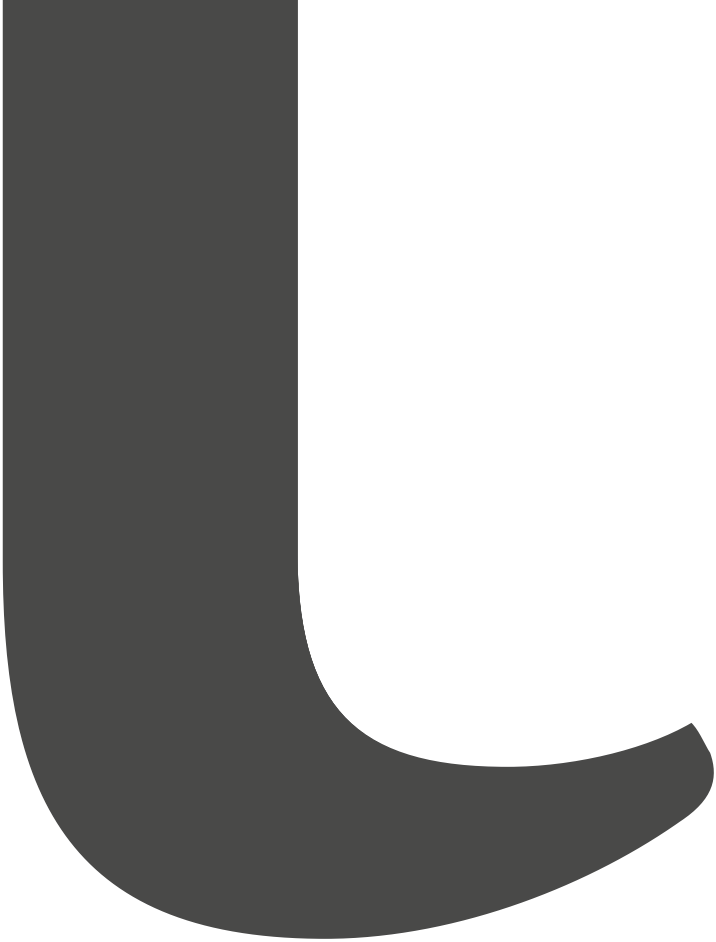
S

y

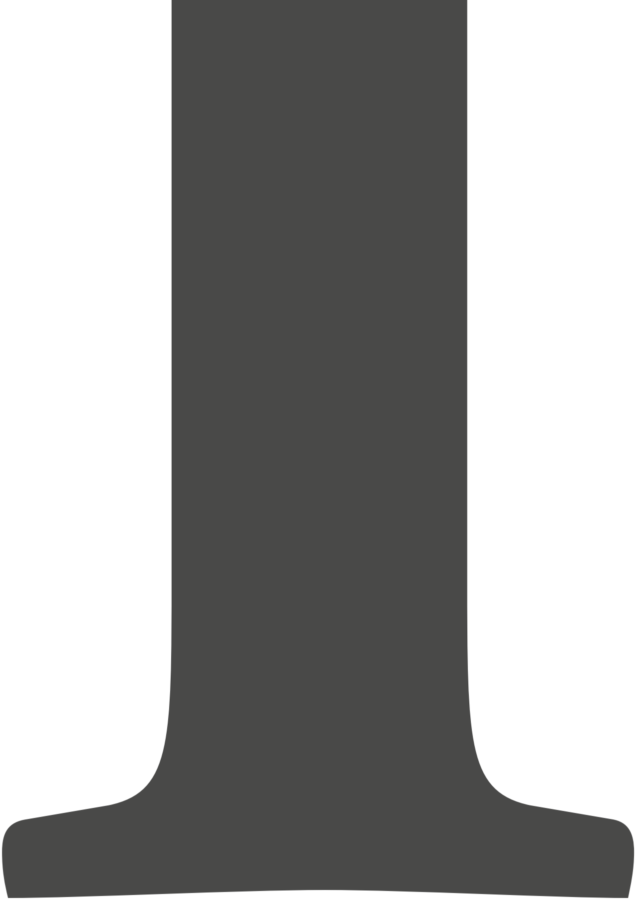
a

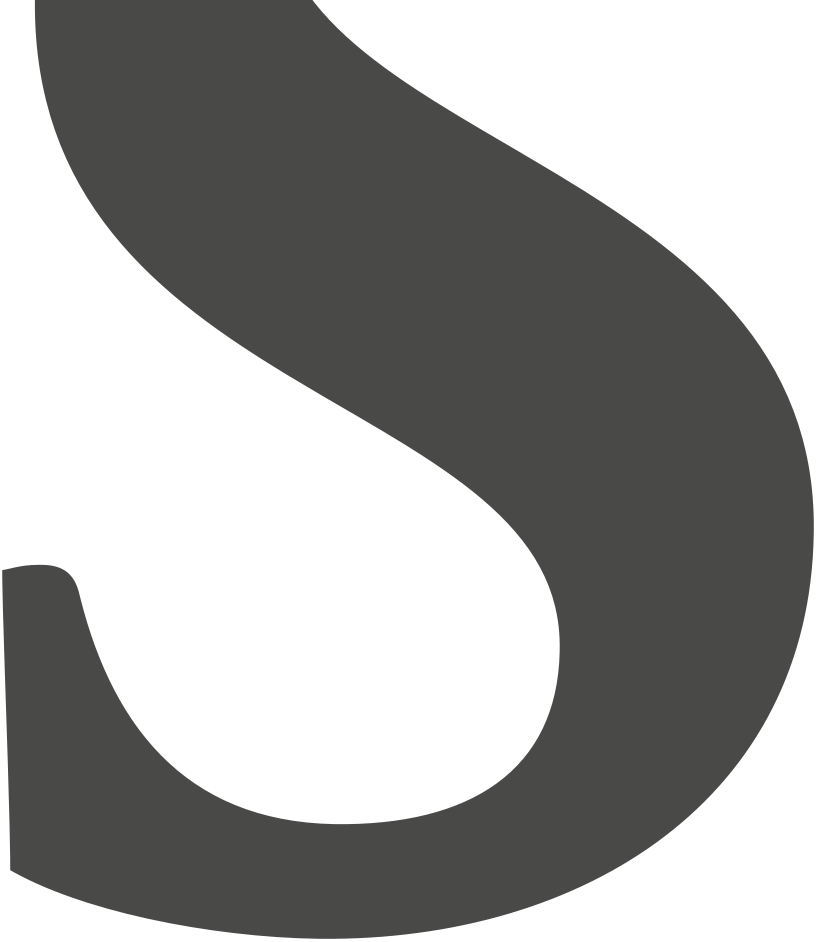
V

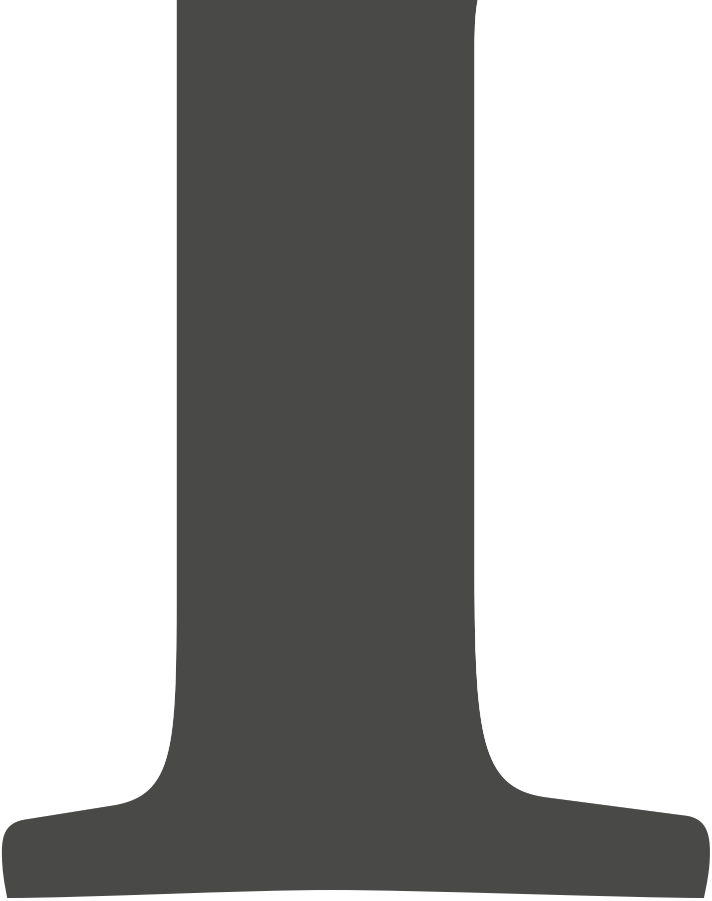


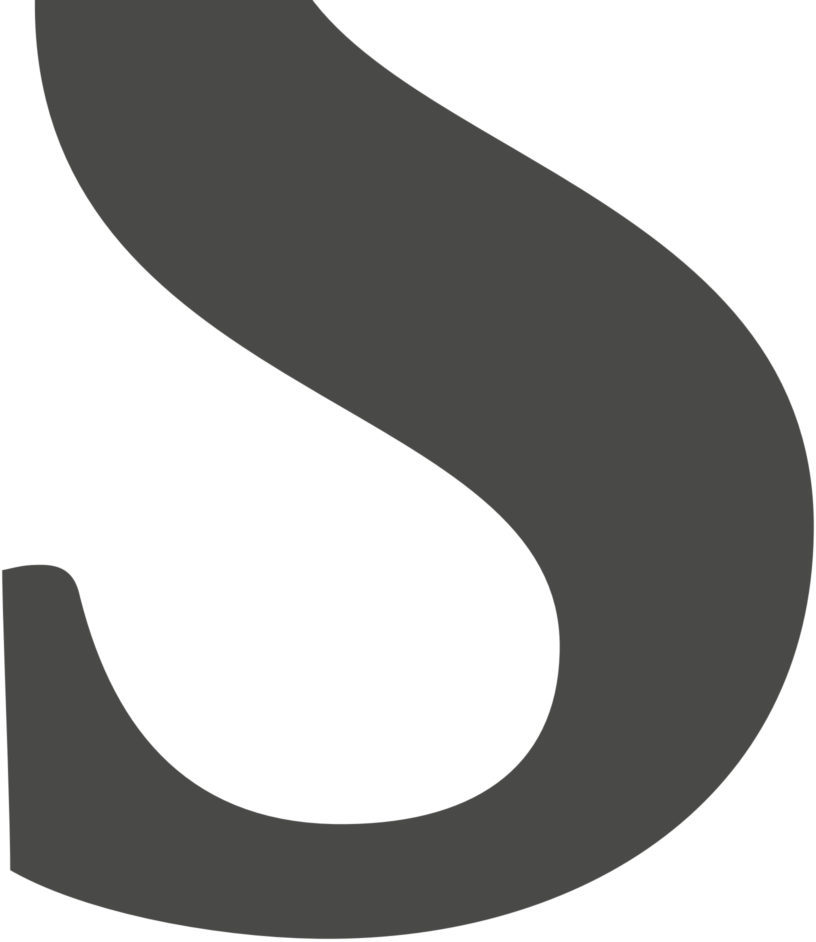


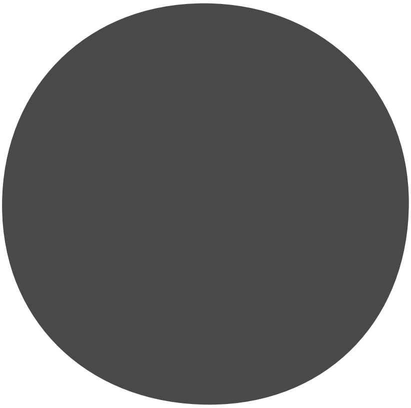
y







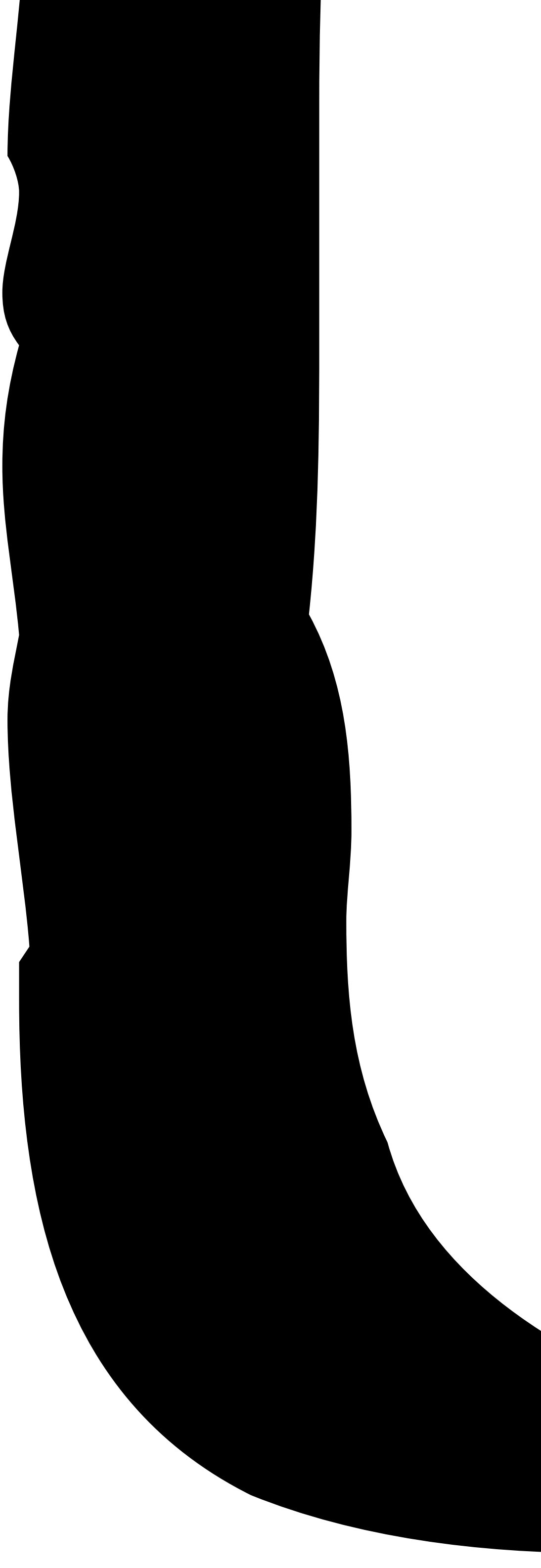


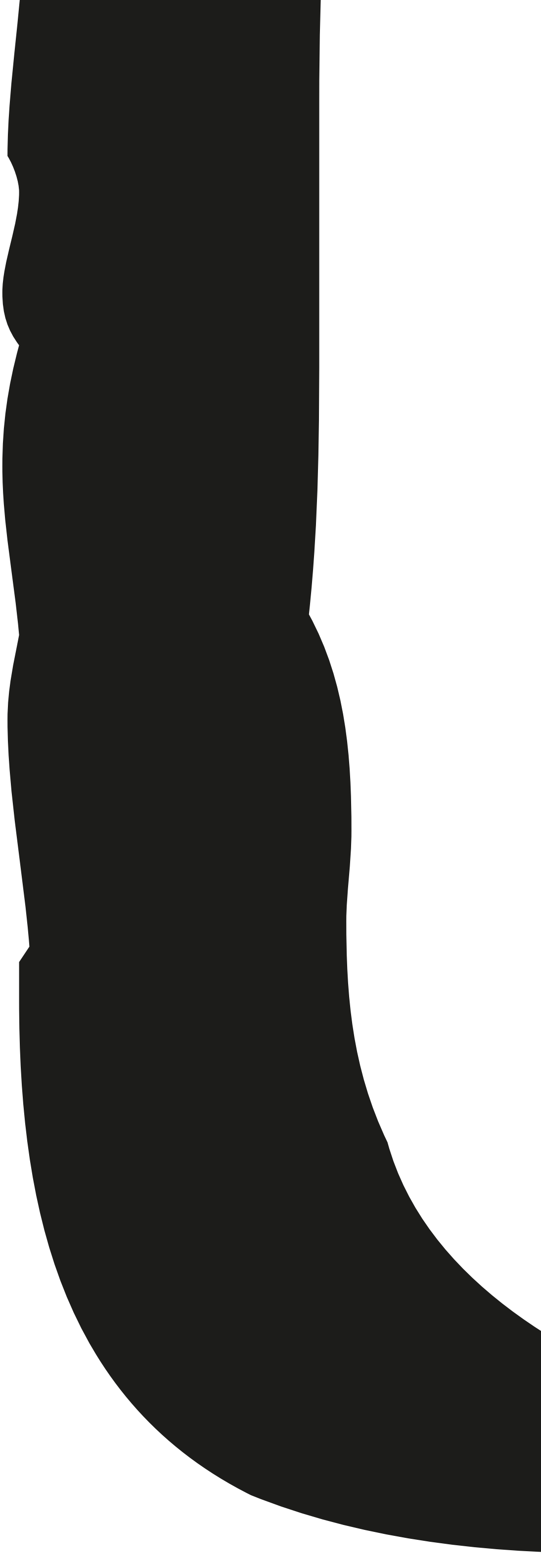


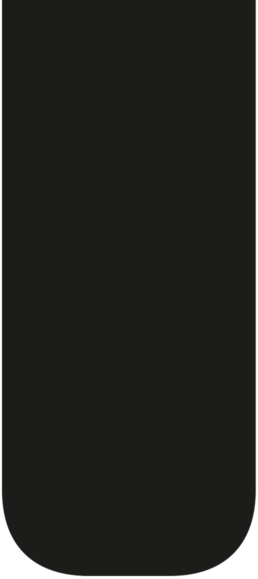
E

12

Plants of the world







M

n

in

lt

th

C

m

T

fl

lo

A

t

T

n

re

up

Ki

N

A

W

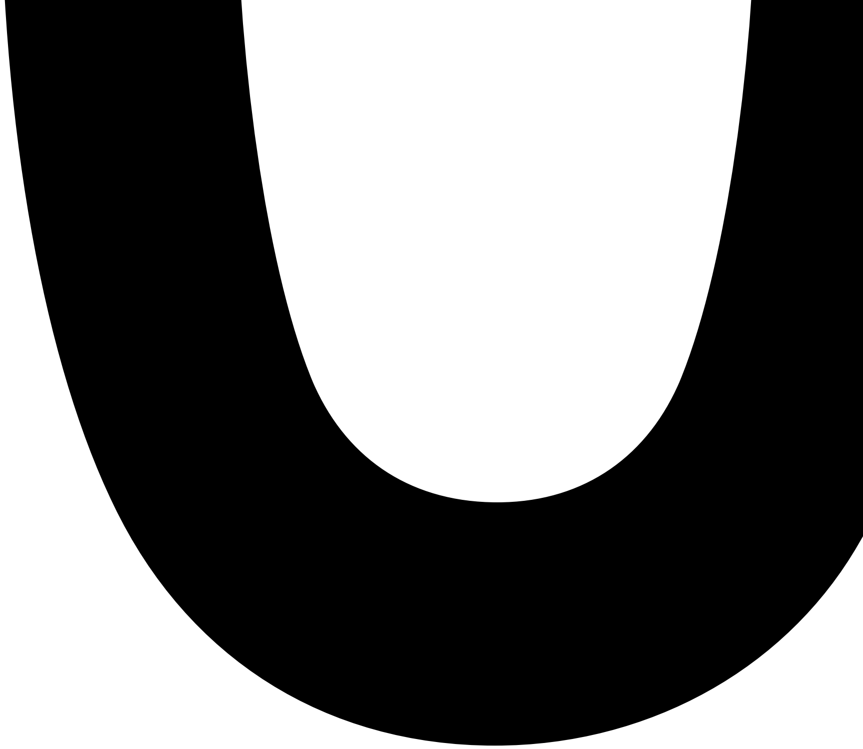
p

fl

u

PLANTS OF THE

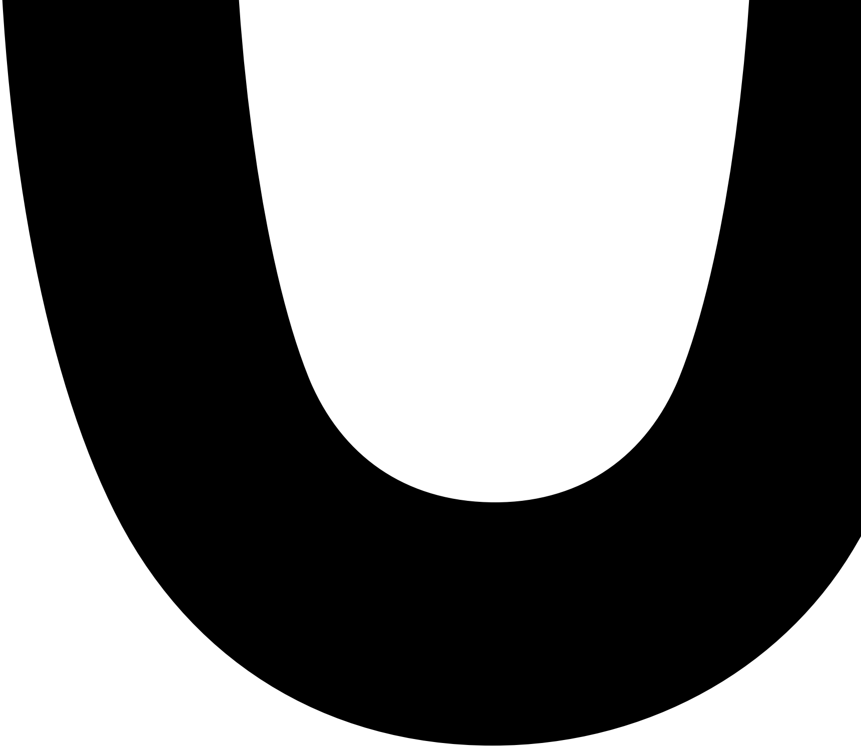
[redacted]

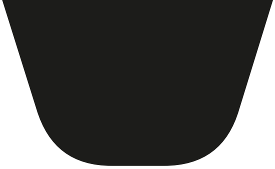


[redacted]

[redacted]

"





T

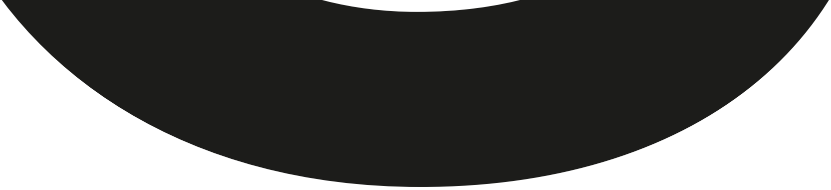
O

y

in

rib

liv



S

liv

b

2

H

H

h

n

tu

its

Pe

h

th

S

W

S

h

cr

W

re

T

h

ro

sh

lo

T

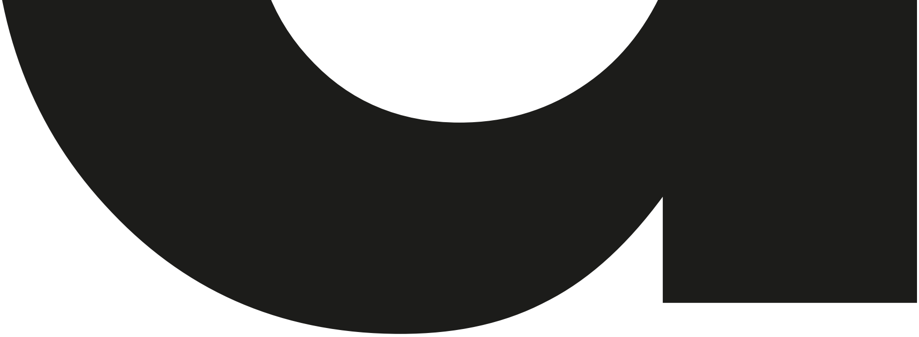
O

D

st

Glossary

10

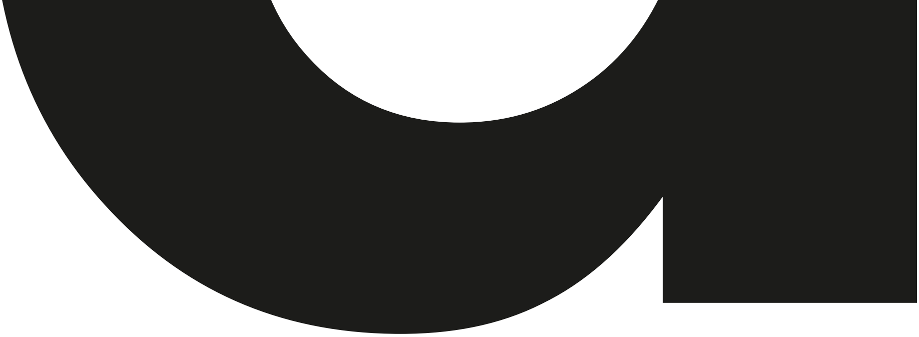


t

O

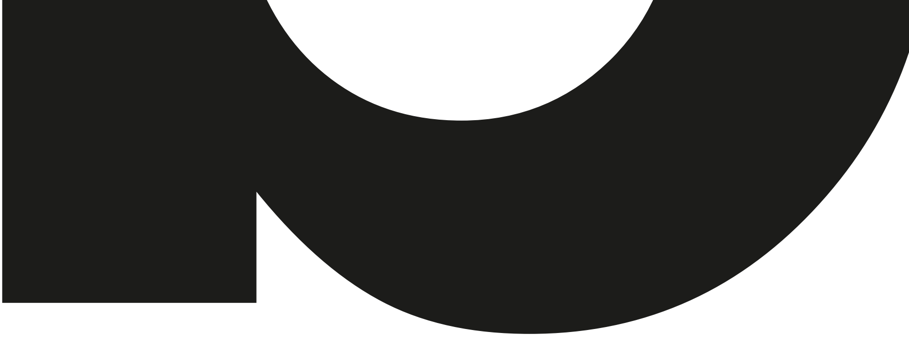
a

Se



t

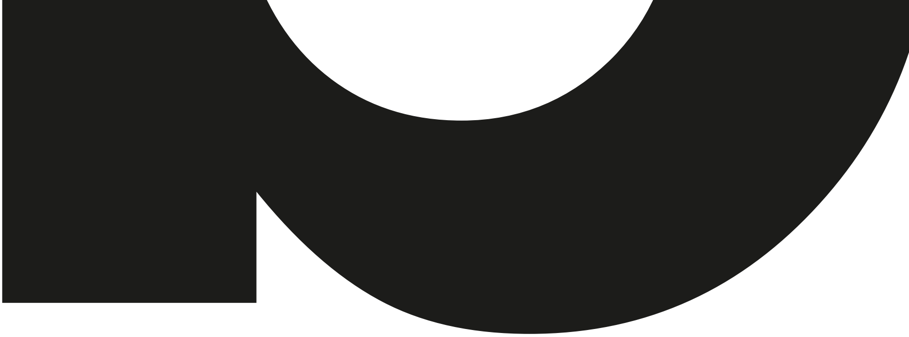
th



t

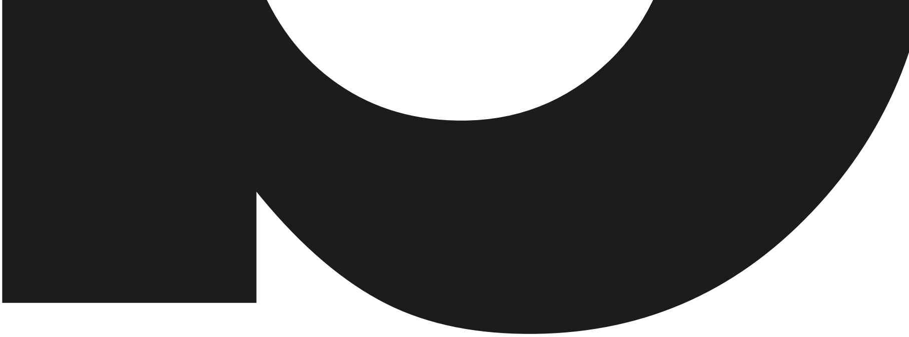
a

U



t

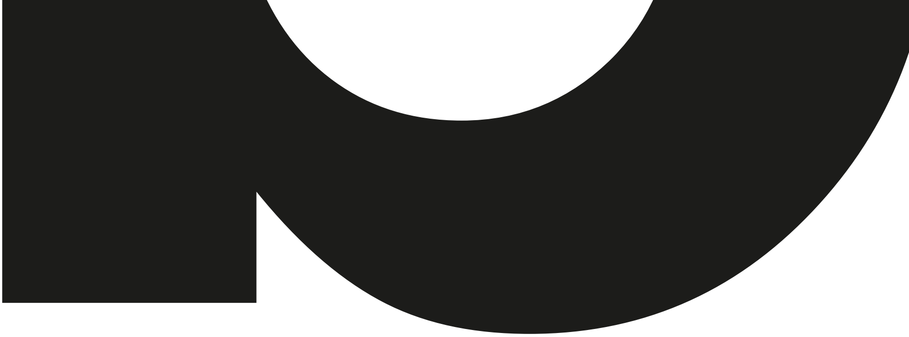
m



f

b

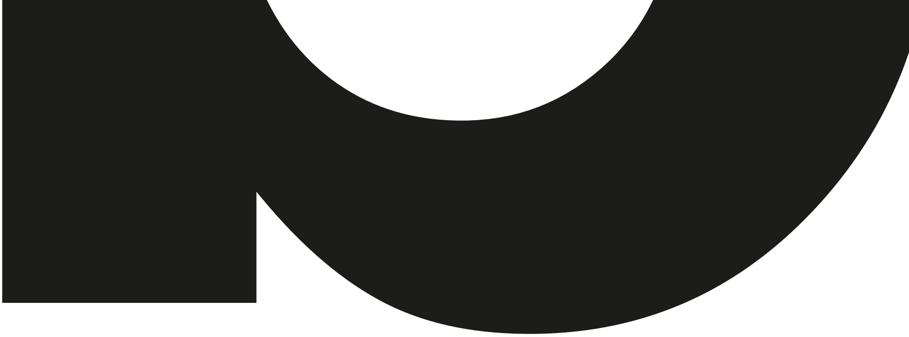
p



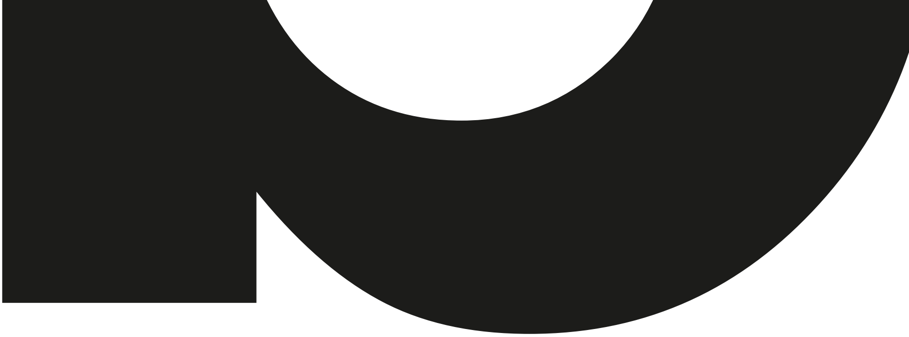
t

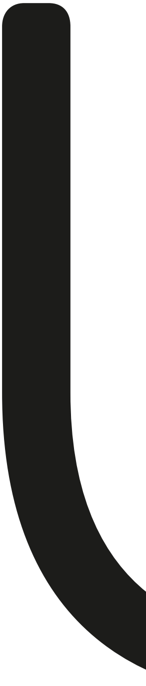
b

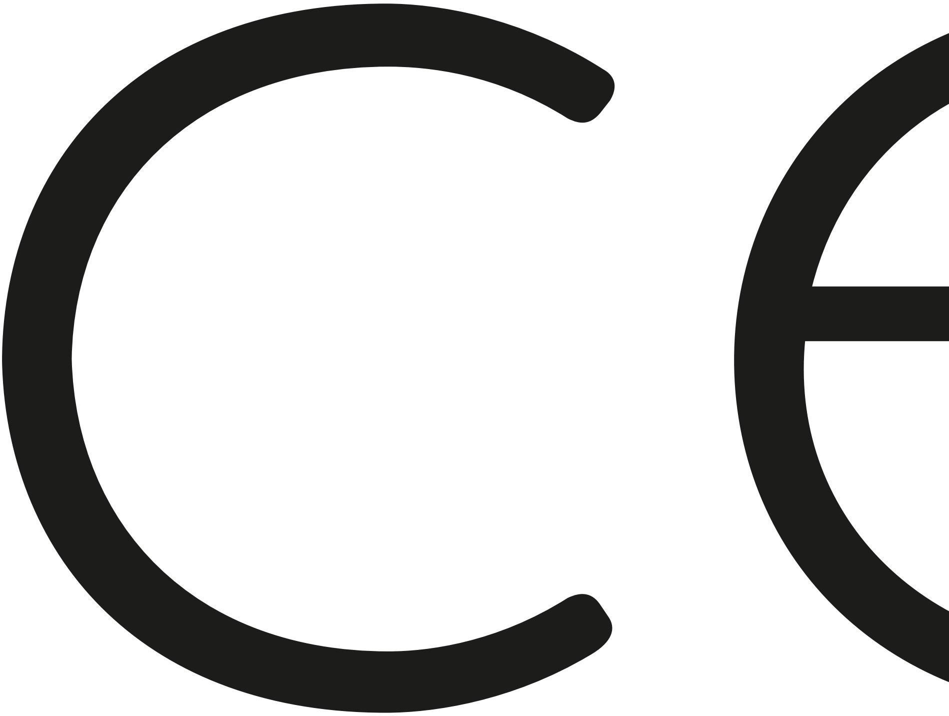
C



ne



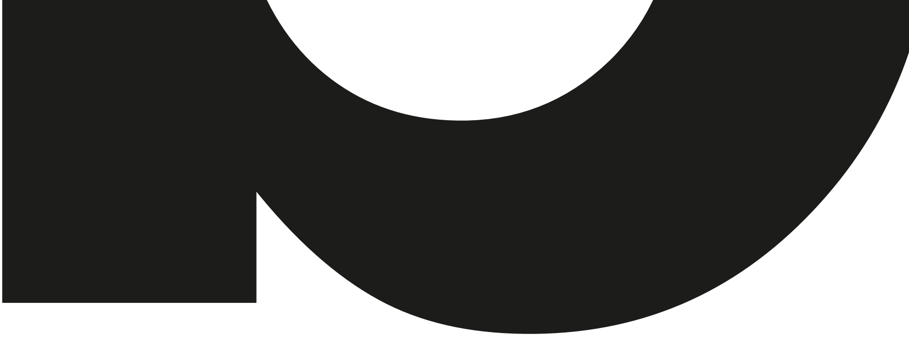




le

W

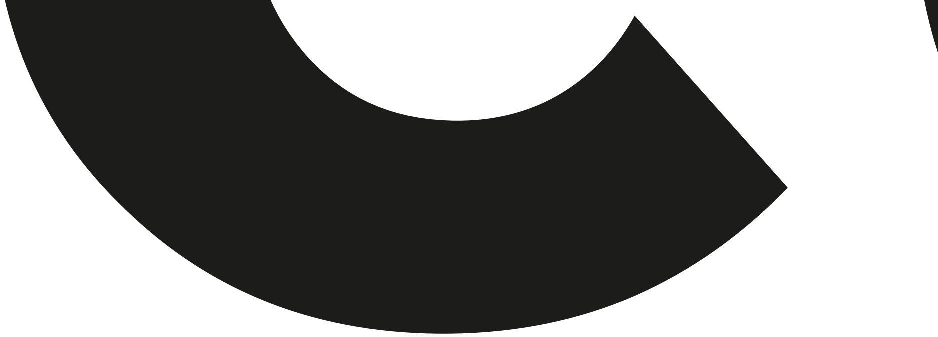
of

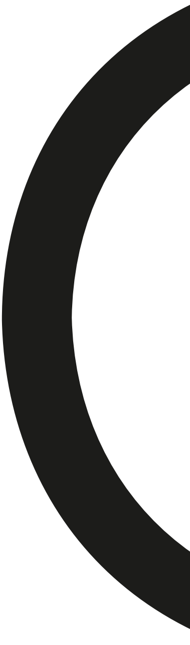


S

si

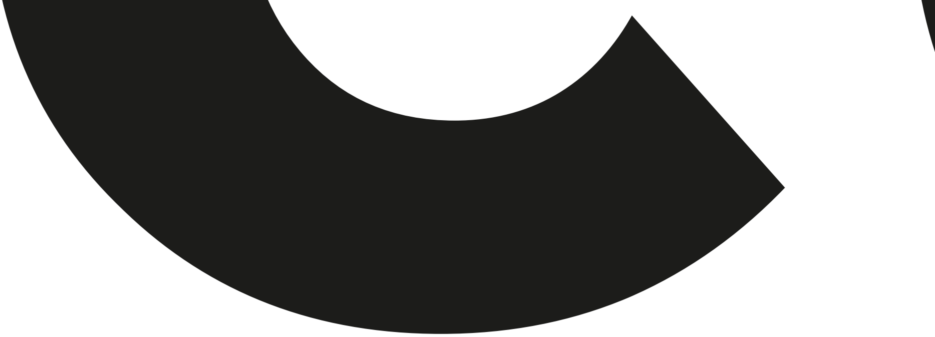
g





a

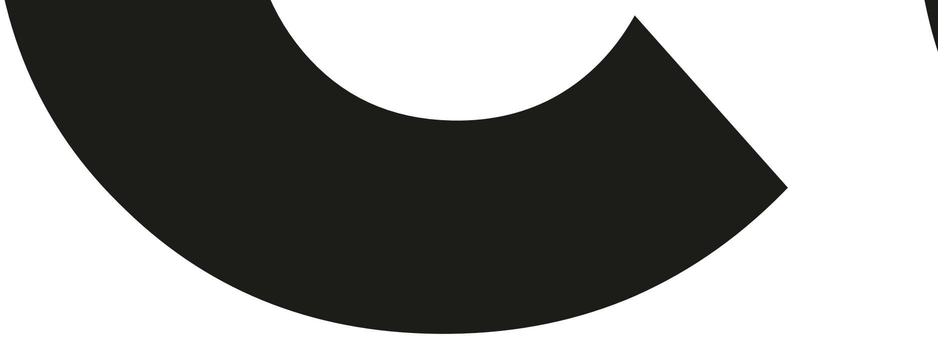
a



t

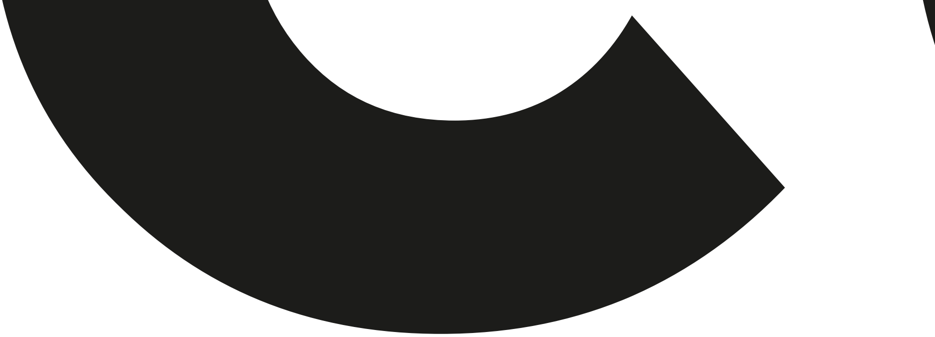
m

Su



fl

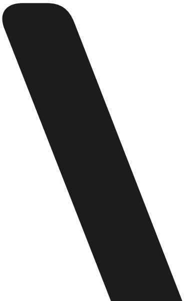
p



t

p

W



fr

in

C

cr

st

se

b

in

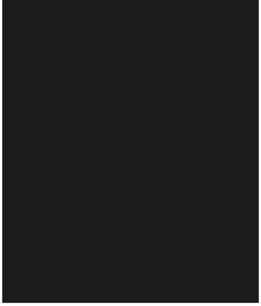
di

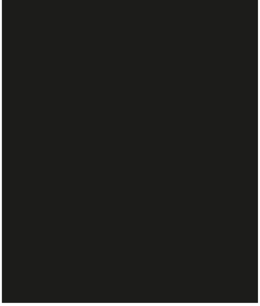
a

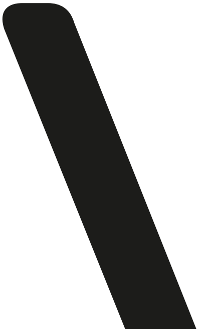
m

se

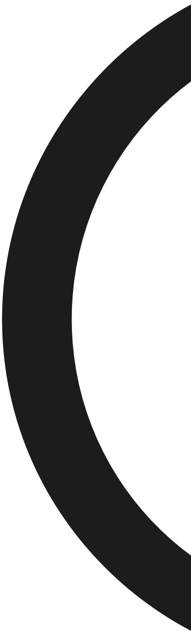
a

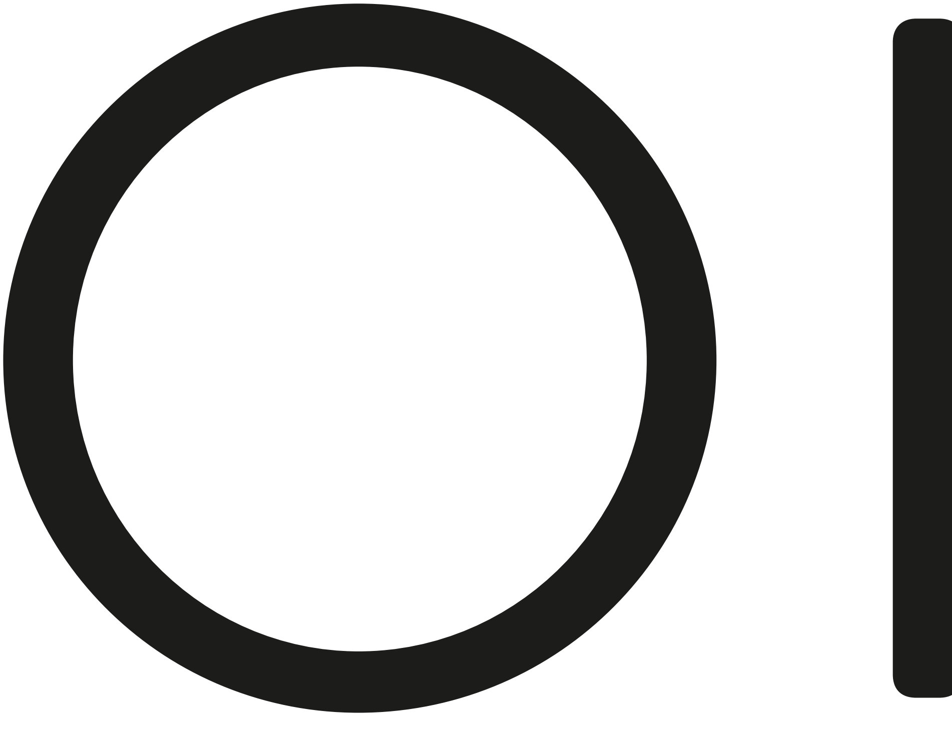




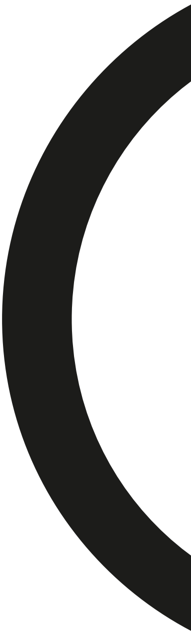


th





nu



di

C

S

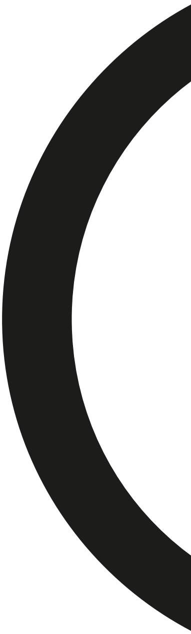
O

of

C

T

ch

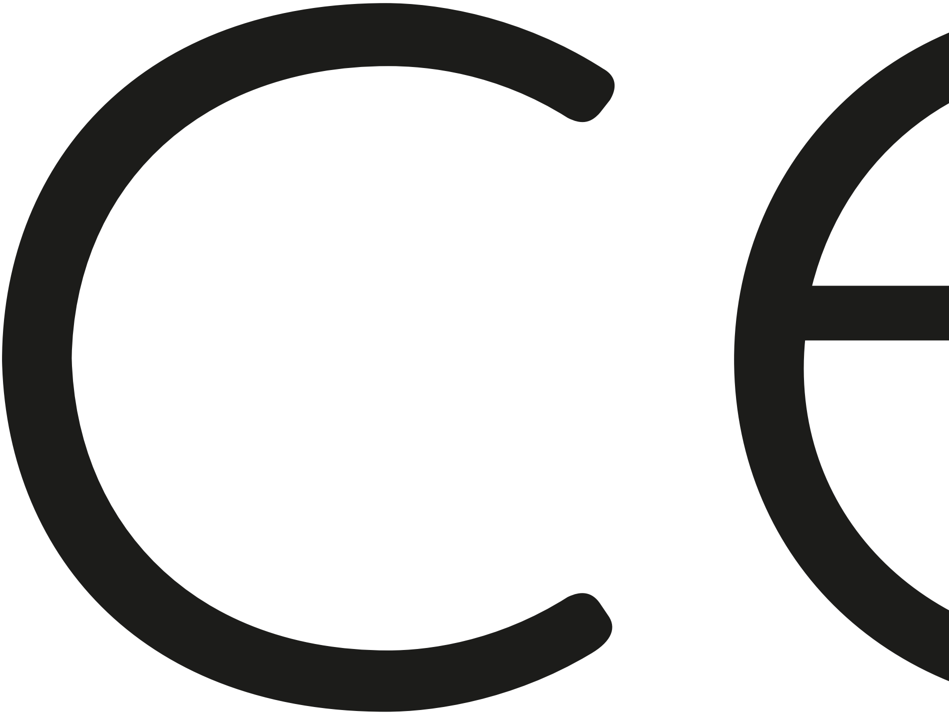


b

sh

in

a

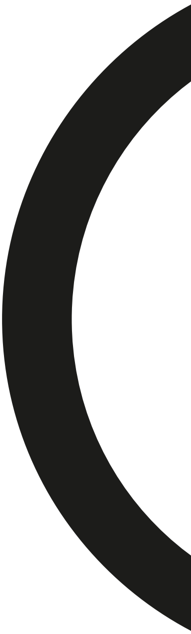


SU

p

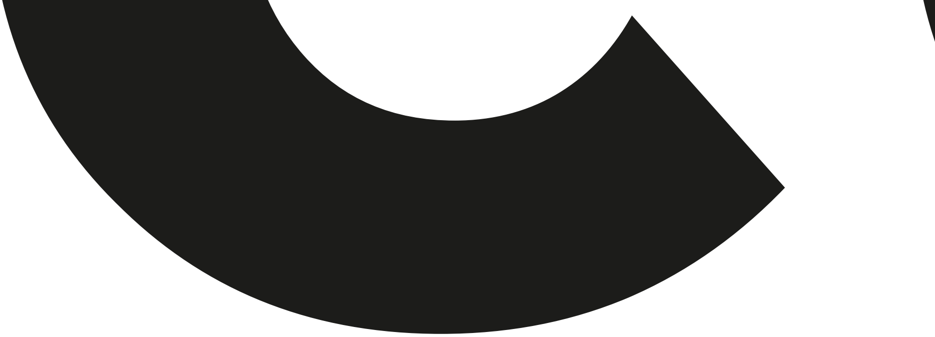
ch

of



C

S

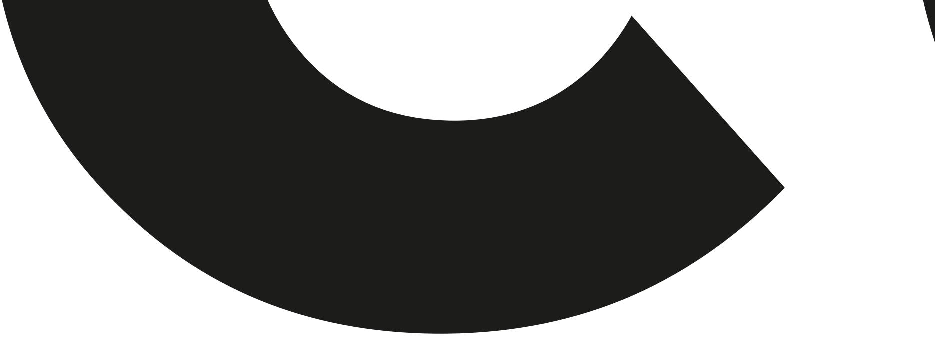


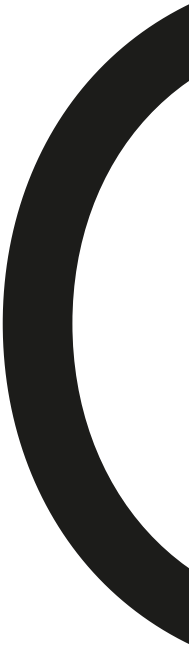
S

t

C

m



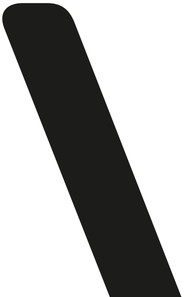


ne

C

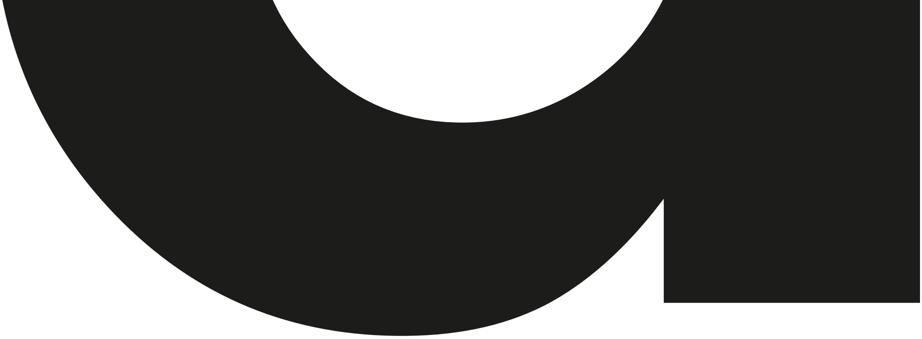
h

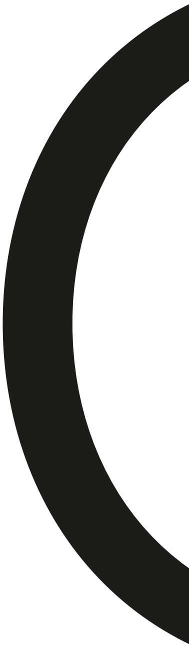
R



p

O





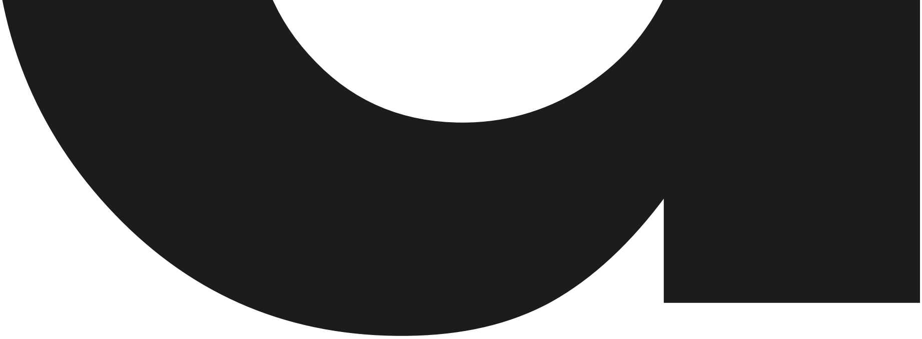
10

in

th

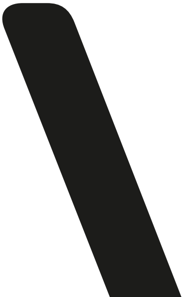
of

b



t

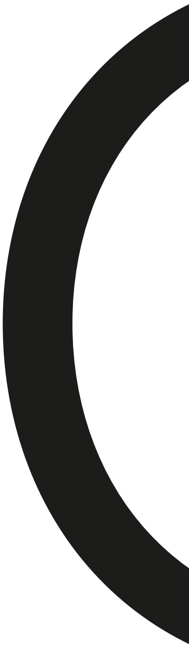
a



b

p

a



h

p

us

fl

p

ne

t

th

a

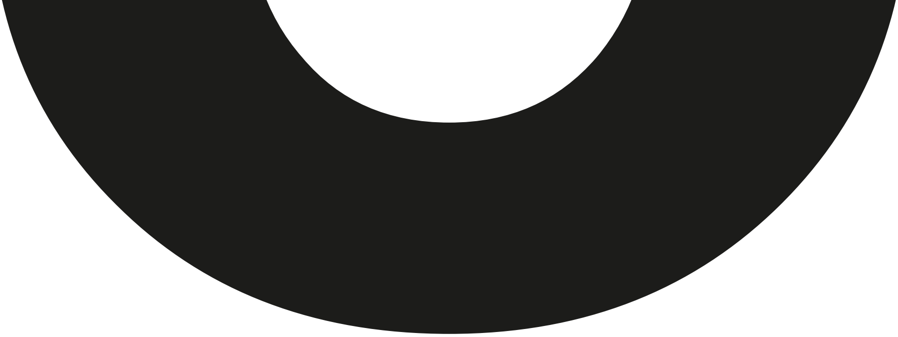
th

a

S

th

im



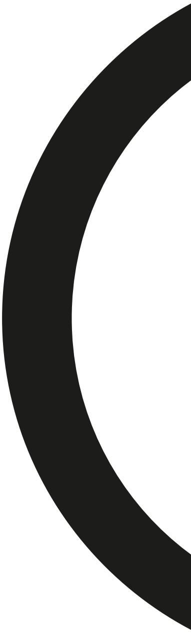
its

fo

m

t

a



fr

m

n

it

C

p

p

th

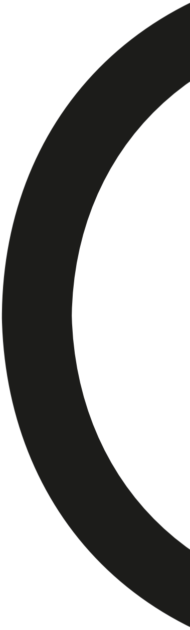
C

SU

t

p

Si



ex

m

p

fo

M

le

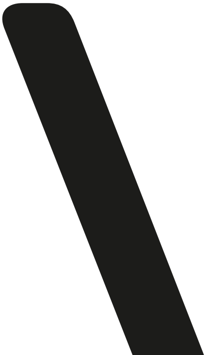
t

O

t

m

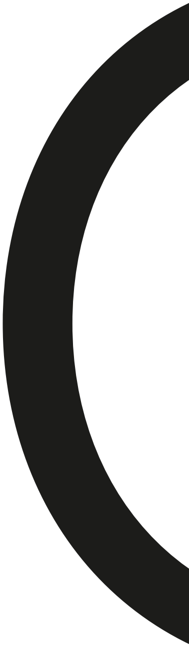
C



fr

th

of



p

a

m

ex

a

t

es

b

t

th

p

a

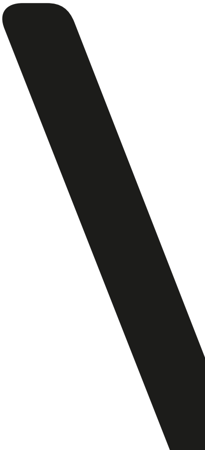
us

t

th

in

sp

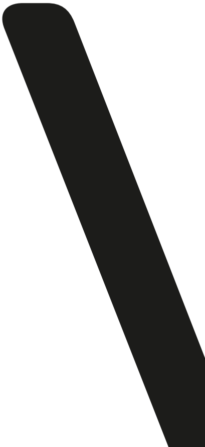


us

W

se

S



p

ne

t

a

O

t

W

a

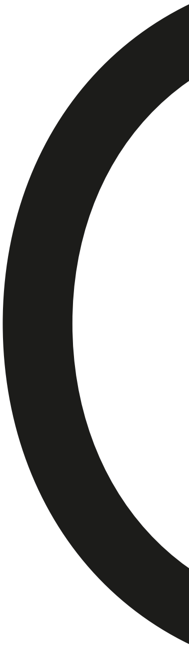
of

a

t

th

a



se

to

in

p

tr

C

f

re

th

st

le

S

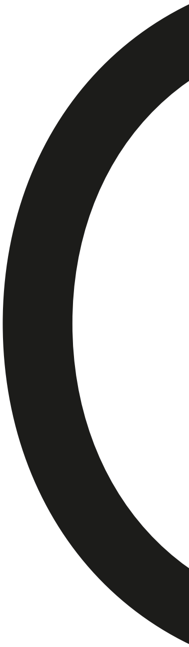
th

S

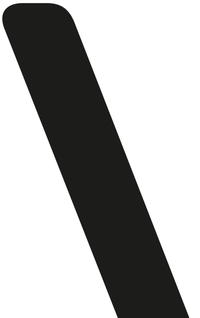
as

t

a



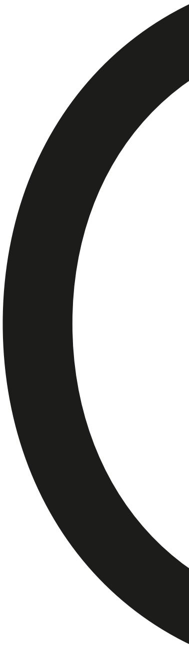
re



st

t

ro



ne

a

t

a

W

a

t

di

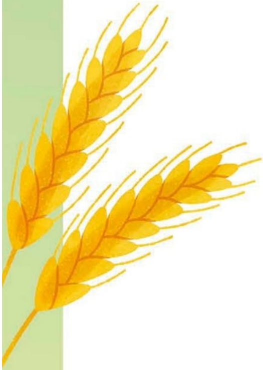
ot

f

in

ch

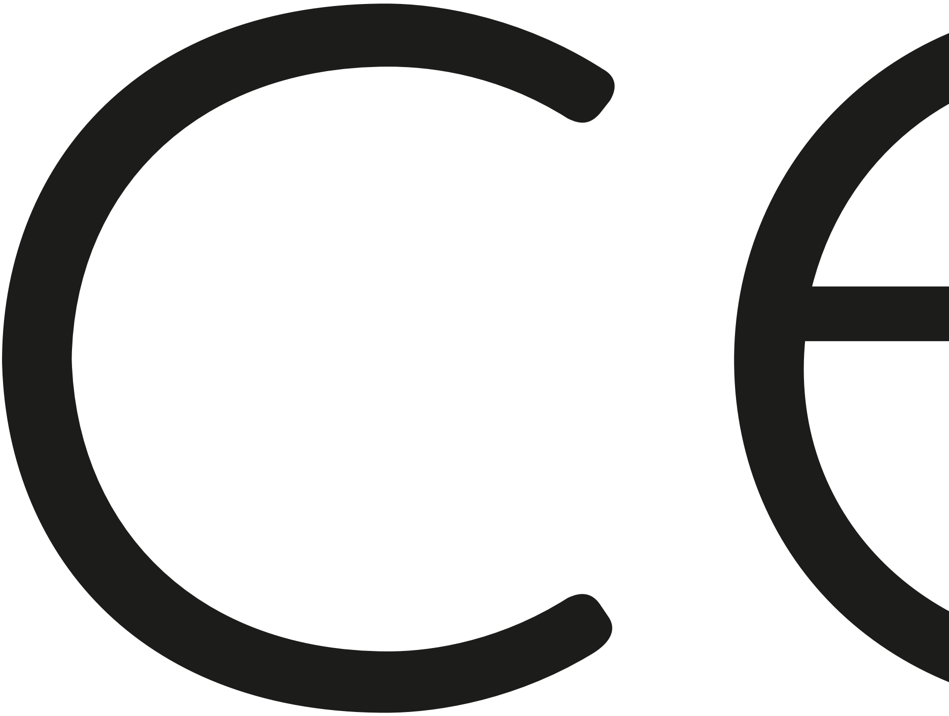
a

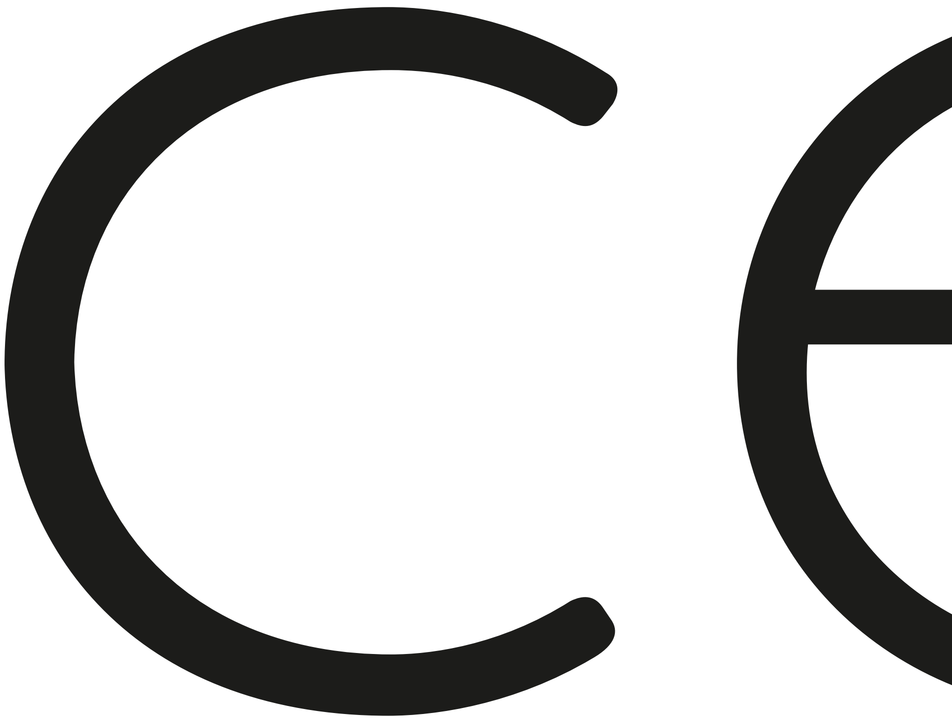


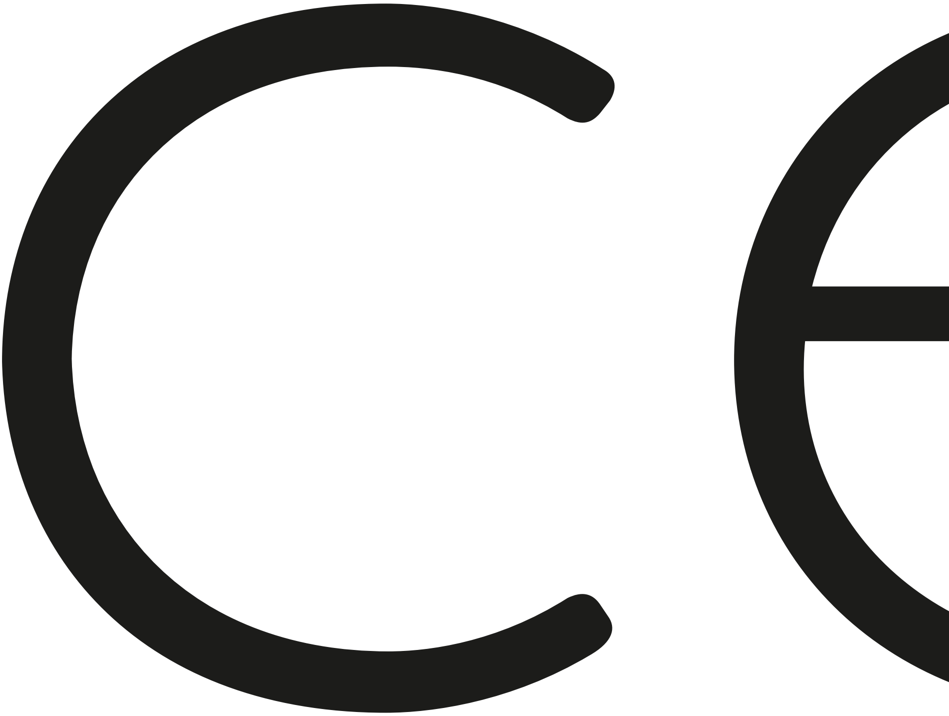
Index

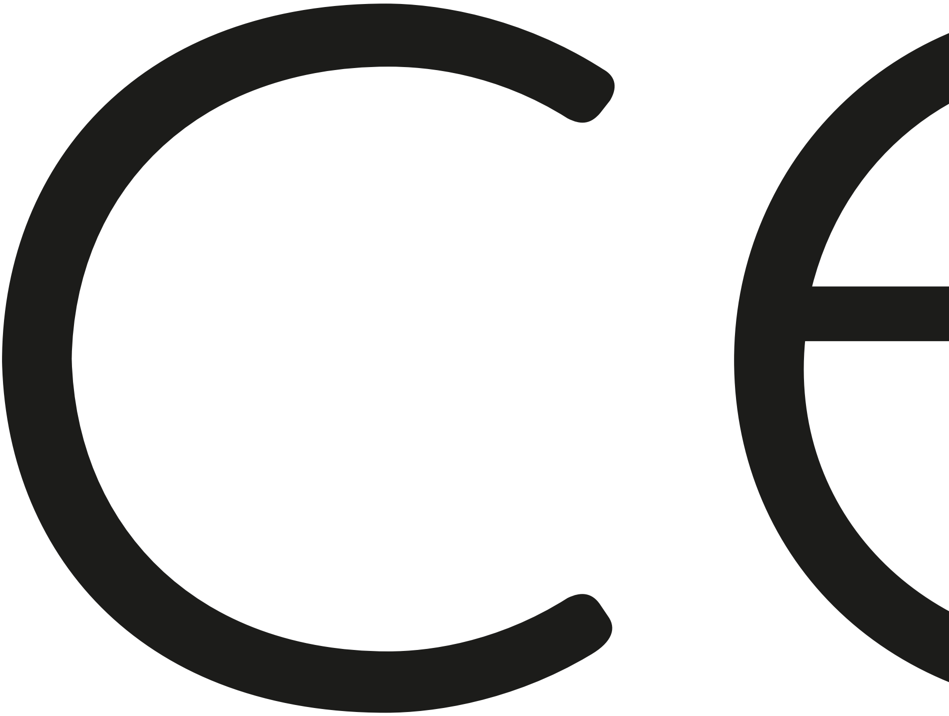
C

C









ch

ch

ch

ch

C

ch

ch

C

C

Ci

Ci

Ci

cl

cl

cl

cl

cl

cl

cl

cl

C

C

C

C

C

C

C

C

C

C

C

C

CO

C

C

C

C

C

C

b

b

17

b

b

b

b

b

b

b

b

b

b

b

B

b

b

b

b

b

b

b

b

b

b

b

b

b

C

C

C

C

C

C

C

C

C

C

C

C

C

C

a

a

a

a

A–

a

a

a

a

a

a

a

a

15

a

A

A

a

a

a

A

a

A

b

b

b

b

b

b

b

b

b

b

b

b

b

b

15

b

b

bi

h

h

ho

h

he

h

he

he

he

he

hi

H

h

h

h

hu

h

h

h

H

iC

In

15

in

in

12

in

in

iS

j

jo

J

jo

je

je

ju

J

K

K

K

K

ke

ke

K

ki

ki

K

fe

fe

fe

fe

fe

fi

fil

fi

fi

fl

fl

fl

fli

fl

fl

fl

fl

flo

fly

fo

fo

fo

f

fo

fo

fo

fr

F

fr

fr

fu

g

g

g

g

g

g

g

g

g

g

g

g

g

h

h

h

h

h

h

h

H

cr

cr

CU

C

C

C

Cy

d

d

d

D

d

d

d

d

d

6

d

d

di

di

di

di

d

d

D

D

d

d

d

d

d

d

e

e

E

ei

el

el

e

e

et

et

e

ex

ex

fo

fe

15

p

p

p

p

p

p

12

p

p

p

p

p

p

p

p

p

p

p

p

p

q

q

q

ro

ro

ro

ro

r

re

re

re

re

re

rh

rh

ri

rig

ro

ro

ro

ro

ru

ru

S

S

S

S

S

S

N

ni

ni

n

n

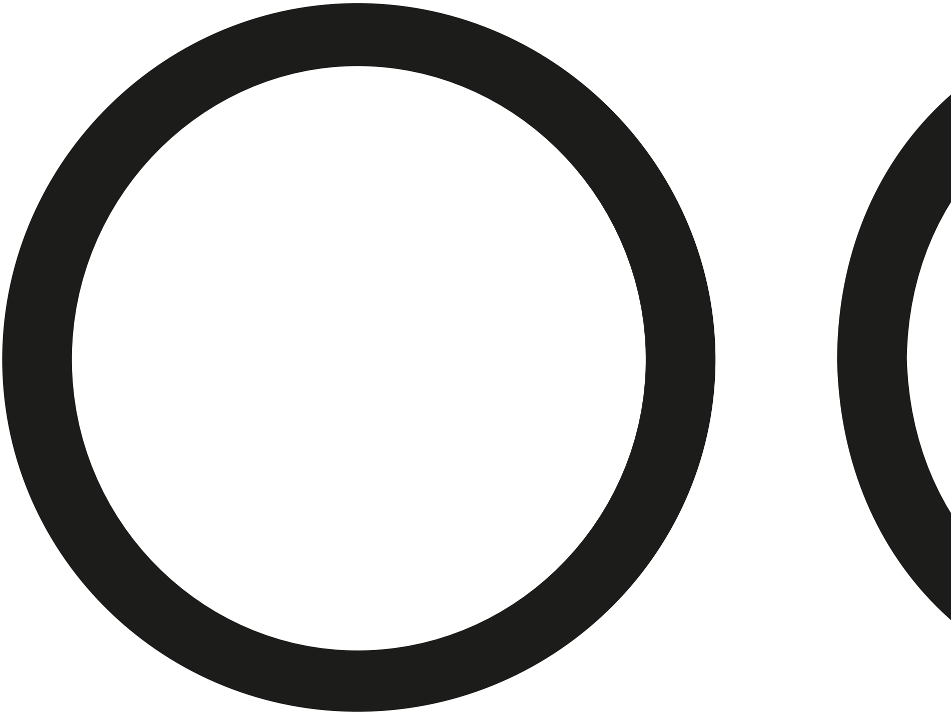
n

N

nu

n

O



oi

O

O

O

OX

p

p

p

p

p

p

p

15

p

p

p

p

p

p

p

p

p

p

p

p

p

p

p

p

p

pi

p

p

p

p

p

p

p

p

lo

L

lo

lo

lo

le

le

le

le

li

li

lig

lil

liv

liv

L

lu

ly

m

m

m

m

m

m

m

m

m

M

m

M

M

m

m

m

m

m

m

m

m

m

m

n

ne

17

ne

ne

ne

ne

S

S

S

S

S

se

se

se

se

se

14

se

se

se

15

se

se

Se

se

se

se

sh

sh

sk

sl

sr

sr

sr

sr

SO

S

SO

sp

sp

sp

sp

sp

sp

sp

sp

sp

Sp

sp

sp

S

S

st

st

st

st

st

st

st

st

st

st

st

st

st

SU

SU

SU

SU

11

SV

SV

SV

t

t

t

t

t

te

te

te

te

te

T

th

th

ti

ti

tit

t

t

1

tr

tr

tr

tr

tr

tr

tr

tr

tr

tr

tr

tu

tu

tu

tu

t

tu

ul

V

VO

V

Ve

Ve

Ve

Vi

Vi

Vi

Vi

w

W

w

w

W

w

w

w

w

7

w

W

w

W

W

W

w

W

w

w

w

17

W

W

w

w

W

W

ye

DK | Penguin Random House

For the curious

FSC
www.fsc.org
MIX
Paper | Supporting responsible forestry
FSC™ C018179

D

al

C

Pi

Th

(K

6

bl

Dr

Ph

Sc

Fr

Fo

74

D

Dr

A

8 [

D

9

A.J

10

K

11

AI

Dr

A

12

H

13

g

Dr

N

H

15

K

16

St

Dr

A

Ag

19

lv

20

Jo

(cr

Dr

V

21

bl

Mi

22

ing

Dr

A

24

Ale

Dr

R

26

R

im

30

Br

Sh

Li

33

Ph

bl

Dr

Ve

35

A

So

Ge

P

36

Jo

Do

37

a

38

bl

40

St

(c

Dr

G

M

41

D

43

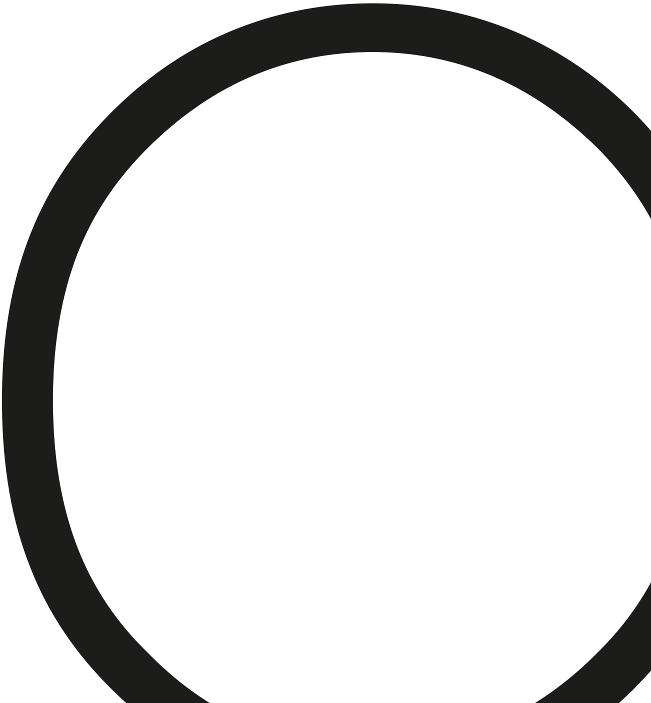
Fr

Pe

44

P

Dr



46

P

Sy

50

Sc

P

52

W

Vie

Dr

M

55

ch

56

Al

E

58

M

58

Z

60

St

B

Dr

W

Sh

Re

61

Al

C

62

M

62

Zo

64

K

65

Je

Lt

“

Ex

68

G

70

T

W

72

Jo

73

M

Sc

Dr

Je

Sh

T

74

C

Ge

C

76

St

Re

79

K

80

FL

82

Lib

C

82

A

84

Z

87

De

W

88

be

Dr

Jir

89

St

D

Dr

A

91

D

Bu

92

D

92

M

94

Dr

A

96

A

99

A

10

St

Pi

10

Ko

10

W

na

10

Ke

10

P

Do

G

11

H

Ge

kj

/ E

111

C

Dr

N

Pa

112

W

Dr

Ai

11

B

Os

11

Jo

118

Ri

12

D

Ba

Dr

S

12

H

Dr

Pi

12

St

R

12

G

12

C

ag

CO

Sc

D

12

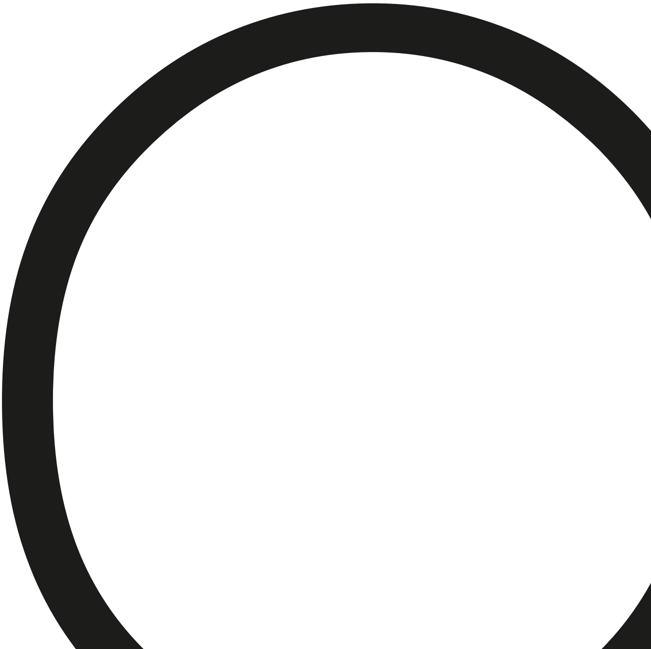
C

/

12

Br

Dr



13

Dr

D

13

Re

13

Rb

Sc

13

St

De

T

Dr

C

13

K

13

Fa

14

Le

14

ne

Dr

CO

M

14

k

14

St

Jin

Dr

St

14

S

14

Ph

15

N

15

er

Gr

15

bl

15

St

15

bli

15

B

Wi

Dr

Av

15

Du

16

K

ca

16

D

16

di

Al

St

M

Ge

ch

Sh

C

16

/iS

at

16

Pi

16

S

16

St

S

17

Y

Sh

im

17

Ph

D

17

Jo

17

17

Hik

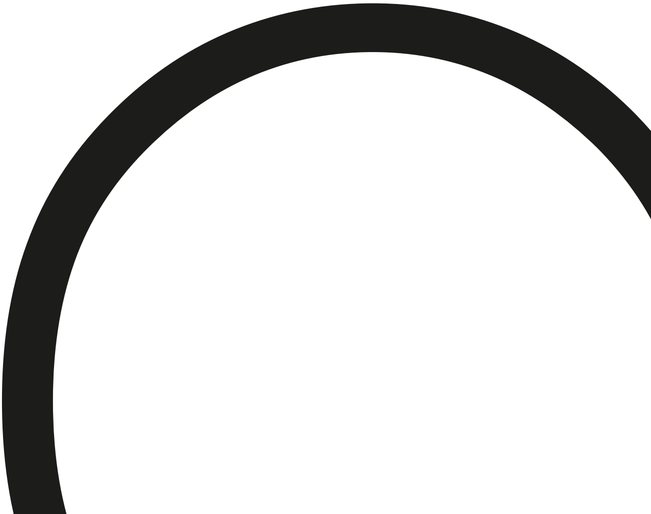
17

H

De

m

Dr



17

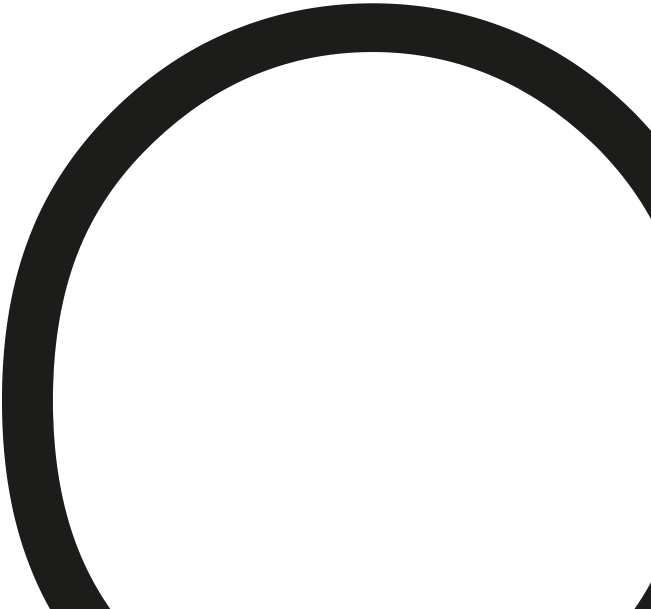
Je

Tei

Al

D

Dr



Ge

Fr

Ka

Sh

FL

18

H

Dr

S

18

Ph

bl

Ge

th

18

C

Le

Dr

Sh

18

Z

18

D

He

De

Bi

Dr

Su

C

Al

bl

He

Dr

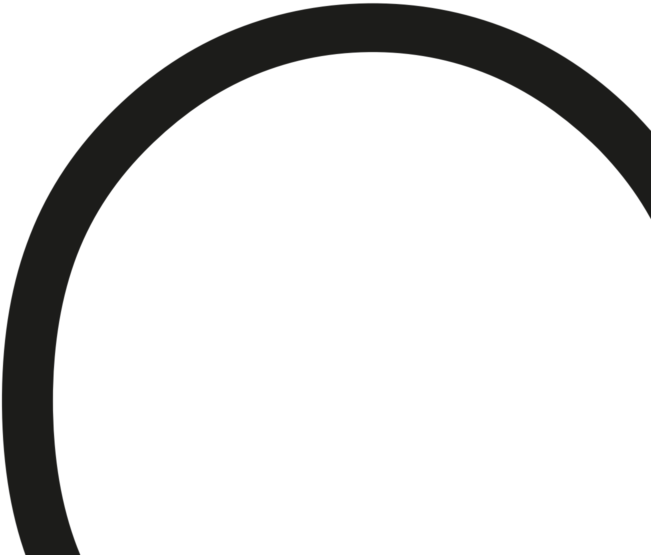
A

Al

Ph

I

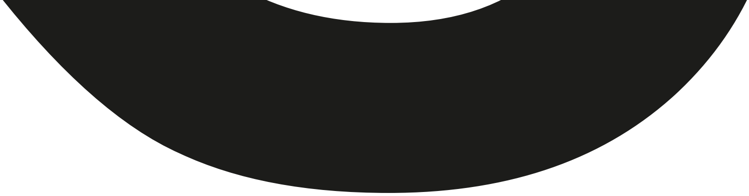
Dr

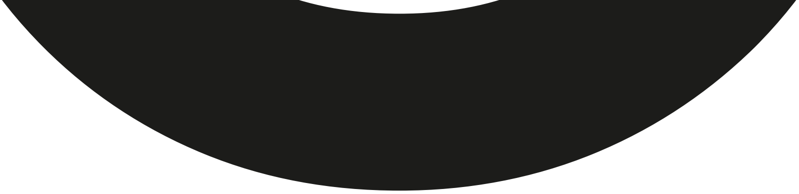


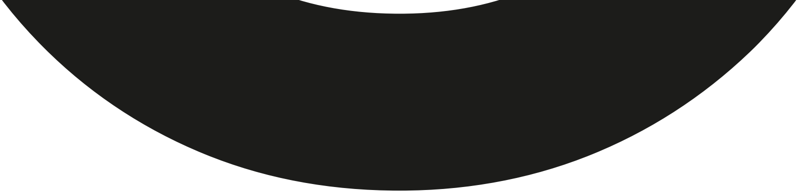
Ge

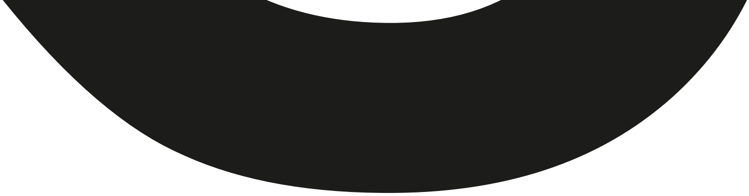
th

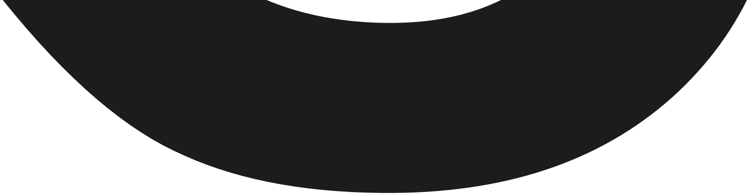
All

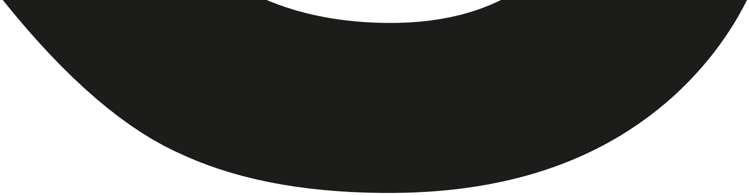


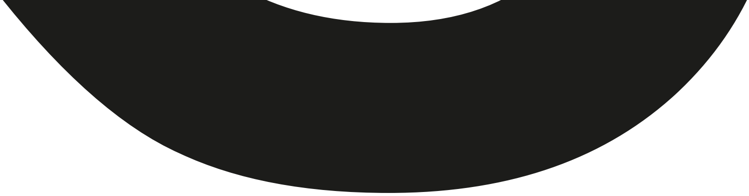


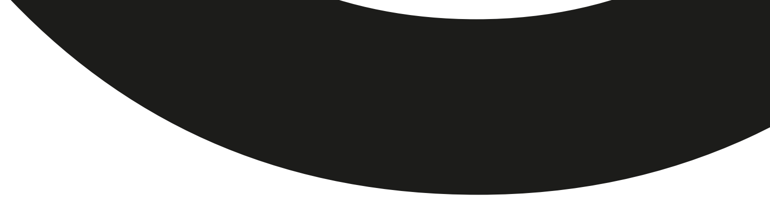












Fi

Pu

1

Te

C

D

2

0

A

W

n

in

or

re

of

Pu

A

is

IS

D

in

e

D

1

S

Pr